Iron AND Steel ENGINEER

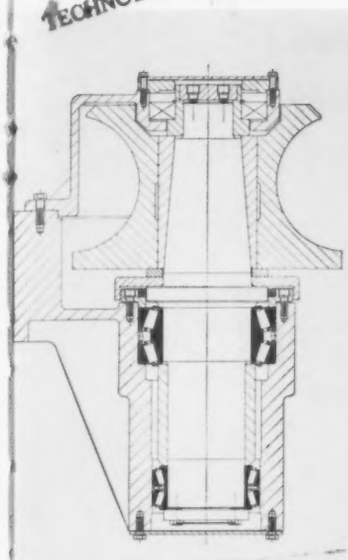
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

ATTEND THE IRON & STEEL EXPOSITION

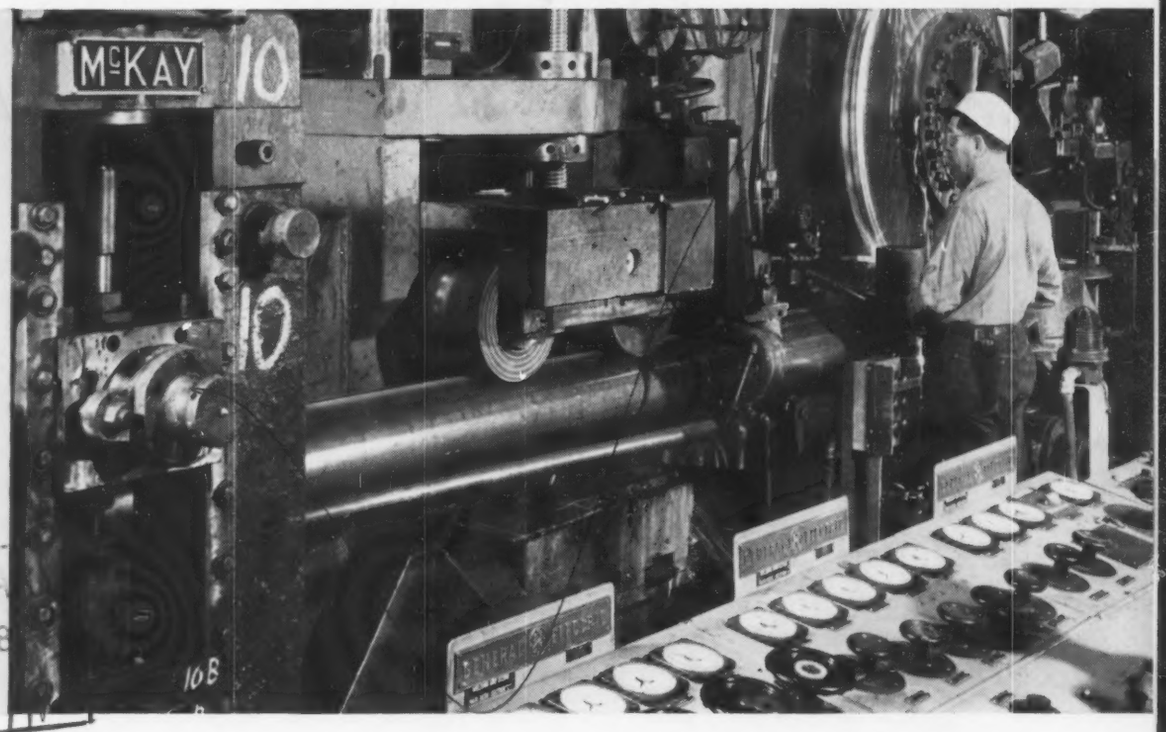
SEPTEMBER, 1958

SEE PROGRAM ON PAGE 176

TECHNOLOGY DEPT.



How McKAY mounts Pipe Mill pressure roll to take heavy loads and reduce maintenance.



SEP 22 1958
DETROIT

Timken® bearings take heavy loads on McKay 12¾" pipe mill at J & L

ROLLING out 120 feet-a-minute of 12¾" OD electriweld pipe, an advanced design McKay Pipe Mill is setting new production records at Jones & Laughlin, Aliquippa, Pennsylvania.

To get this, engineers mounted five Timken® tapered roller bearings on the pressure roll shafts and at other vital points. They take the heavy shock loads as pressure rolls upset the pipe edges during the welding operation. These same bearings must take the terrific sizing loads which are present when any cold pipe comes through the welding pass.

Timken bearings' rollers and races are case-carburized to produce hard, wear-resistant surfaces over tough, shock-resistant cores that add longer life to bearings and machine, smooth the way for minimum down time and record production.

The smoke and spatter of welding operations make tight closures a *must.* Timken bearings hold shafts concentric with their housings, keep dust and dirt *out,* lubricant *in.* Maintenance, of course, stays *down.*

Timken bearings take all the stresses in stride because they take both radial and thrust loads, or any combination of loads. They roll the load. Friction is virtually eliminated because Timken bearings are designed by geometric law to have true rolling motion. And they're precision manufactured to live up to their design.

Timken bearings help put go and life in your machines—to make better products, make bigger profits. That's BETTER-ness. Specify Timken bearings. They're at the hub of BETTER-ness. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

See us at the 1958 IRON & STEEL EXPOSITION • Public Auditorium, Cleveland, Ohio • Sept. 23-26—Booths 134, 135, 136, 137

BETTER-ness rolls on TIMKEN® tapered roller bearings

From iron ore to iron

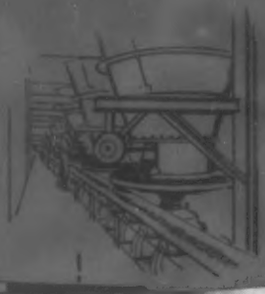
Cutler-Hammer Control sets the pace at USS Fairless Works

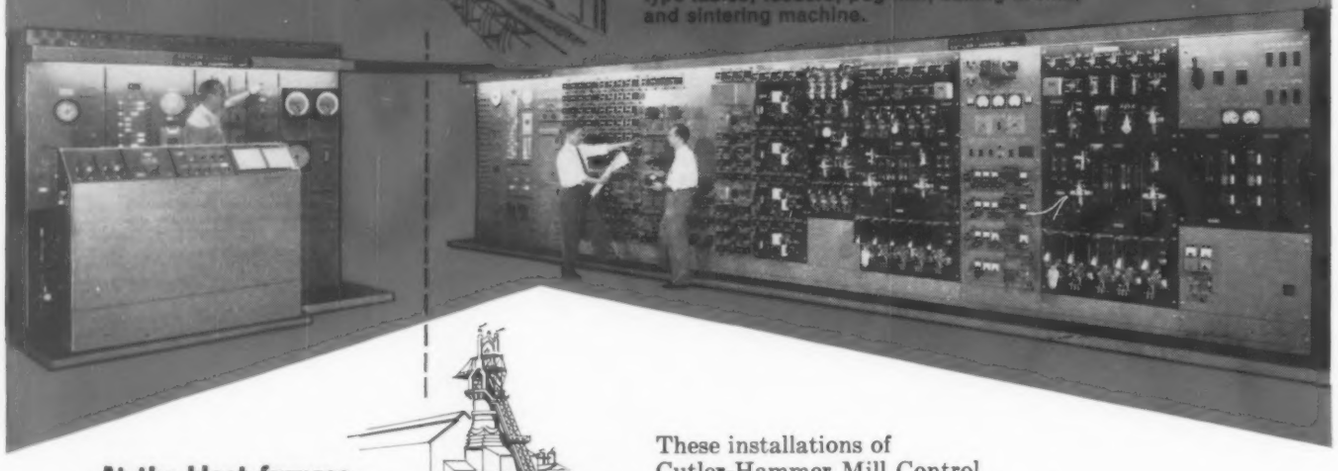
At the ore docks—

Cutler-Hammer Constant Voltage D-c Control directs and protects the operation of the two mammoth ore unloaders and the two ore bridges. Here Cutler-Hammer applied the exclusive Wilson Ritchie emergency dynamic braking control, "Speed-Distance" end zone protection, and bucket protection against overhoisting and excessive cable pay-off.

At the sintering plant—

The highly efficient operation of the Fairless Works sintering plant is a result of the combined engineering talents of Arthur G. McKee, U. S. Steel, and Cutler-Hammer. Cutler-Hammer Unitrol® centralizes the A-c auxiliary controls, and the Magnetic Amplifier Type D-c Adjustable Voltage Drives coordinate the operation of the conveyor type tables, feeders, pug mill, balling drums, and sintering machine.





At the blast furnace—

The new automatic blast furnace charging system is another joint development of Arthur G. McKee and Cutler-Hammer. This revolutionary system completely integrates the proper proportioning and charging of the furnace to follow a pre-selected schedule. Extensive use of visual signals provides a continuous check on the position of the skip cars, number of load on the small and large bells, stock rod position, top temperature and pressure.

These installations of Cutler-Hammer Mill Control quickly demonstrate the very broad experience and engineering knowledge available to you in the solution of your mill control problems. Write today describing your particular requirements . . . your letter will receive prompt attention. Dept. S232, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CUTLER-HAMMER CONTROL C-H

Look to Cutler-Hammer mill experience . . . as broad as it is long

CUTLER·HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. *Division:* **Airborne Instruments Laboratory.** *Foreign:* **Cutler-Hammer International, C. A.**

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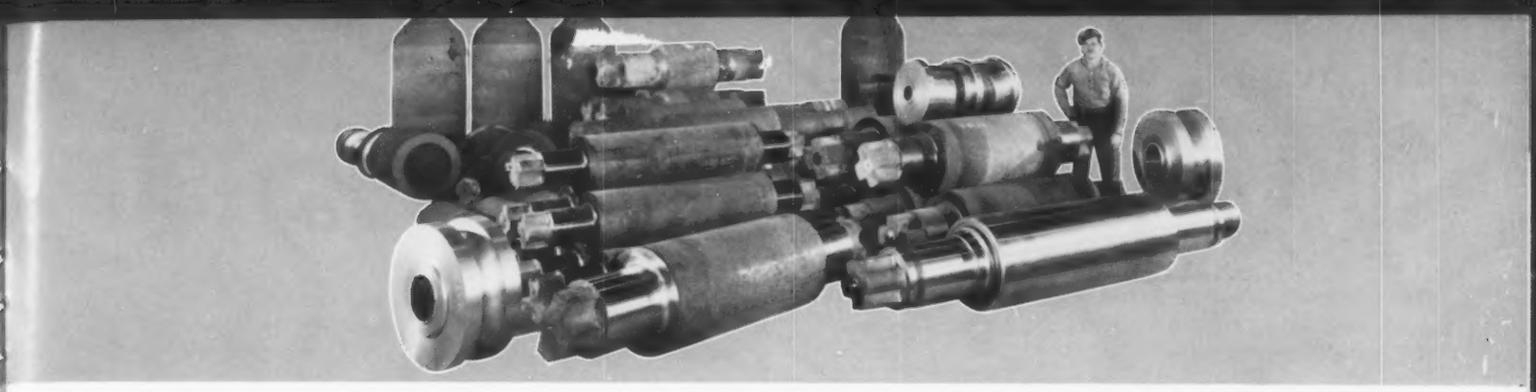
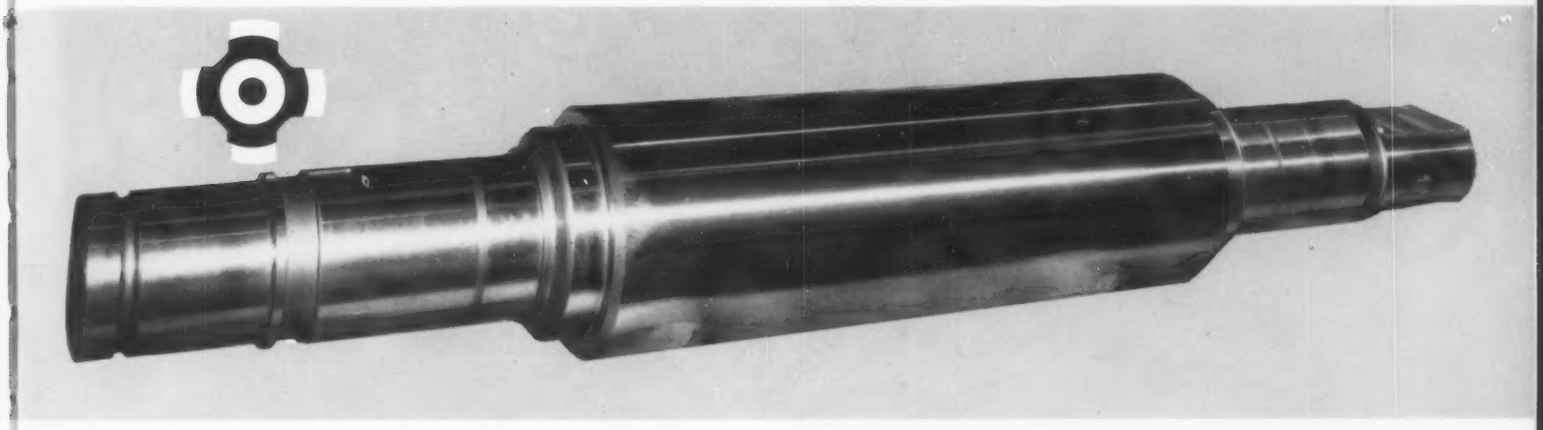


MAGALOY (nodular iron) ROLLS

FROM 7" TO 42-1/2" DIAMETER



TYPICAL APPLICATIONS

MAGALOY GRADE "A"
(Sclerescope Hardness 30-38)
Piercing Mills

MAGALOY GRADE "B"
(Sclerescope Hardness 45-55)
Blooming Mills • Bar & Billet Mills–Roughers
Rod Mills–Roughers • Plug Mills (5½" and over)
Skelp Mills • Hot Sheet Bounce Mills

MAGALOY GRADE "C"
(Sclerescope Hardness 58-65)
Merchant Mills–Leaders and Finishers
Rod Mills–Intermediate Train • Hot Strip Mills
Cont. Bar & Billet Mills–Intermediate & Finishers
Plug Mills (up to 5½")
Tube Mills–Forming & Welding, Sizing, Reelers
Straightening • Skelp Mills • Edging Mills

MAGALOY GRADE "D"
(Sclerescope Hardness 66-70)
For applications requiring higher-than-average strength and hardness penetration.

• MUCH LESS BREAKAGE • BETTER SURFACE ON ROLLED MATERIAL • LOWER COST PER TON ROLLED • WEARING QUALITY OF GRAIN ROLLS • PHYSICALS EQUAL TO CAST STEEL • UNIFORM HARDNESS PENETRATION • SUPERIOR MACHINING PROPERTIES

A SPECIALIST AND A PIONEER IN NODULAR IRON

One of the first licensees (1951) for nodular iron, Aetna-Standard's foundry has built a reputation as a specialist in these rolls (trade name — Magaloy). In the making of nodular iron rolls, control of penetration is most important. So is the skill of the foundry to deliver the same uniformity of rolls order after order. As a pioneer and a specialist in nodular iron, Aetna's foundry has an excellent reputation among roll users and suppliers, particularly for penetration and uniformity of rolls.

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

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The Heroult Electric Furnace:

100% Mechanically Operated

The Heroult Electric Furnace is 100% mechanically operated. All of the movements are handled by motor-driven gear mechanism.

This is a very important advantage—as any engineer will readily tell you—for it eliminates so many maintenance difficulties.

There is nothing about the operation and servicing of the motor-driven, heavy-gear mechanism of the rugged Heroult that any good maintenance man can't easily take care of himself. Seldom, if ever, will you find it necessary to call in an outside maintenance man to keep your Heroult performing efficiently.

Modern Heroult electric furnaces are available in sizes ranging in holding capacity from 6,000 lbs. up to and in excess of 400,000 lbs. Both gantry and swing-type roof-moving mechanisms are available. Door-charging furnaces and furnaces of special design, including units equipped with austenitic steel bottoms to permit induction stirring, can also be supplied.

We welcome an opportunity to help you select and install the Heroult best suited to your requirements. An inquiry to the nearest office will bring complete details.

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ELECTRIC MELTING FURNACES

American Bridge Division of United States Steel

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CLARK offers a NEW, IMPROVED

5 SIZES

CLARK BULLETIN 106
Type "B" DC BRAKES

Built to AISE-NEMA standards for use with 600 series mill motors, this new line achieves economies in size without sacrificing ruggedness. These brakes retain the famous Clark "NUT-CRACKER" principle which has proven successful on heavy-duty industrial applications over many years. It assures more dependable operation and longer lining life by providing equal distribution of shoe pressure on the brake wheel. Simplicity of mechanical operating linkage means fewer parts to maintain and simpler adjustments.

FEATURES:

- All maintenance adjustments made from the top.
- Single adjustment for air gap. Built-in indicator.
- Magnet case and coil easily removable and replaceable without disturbing brake adjustment or releasing brake.
- Coil replacement easily done on the job. Epoxy encapsulated coils.
- Wheel and motor armature easily removable as a unit without disturbing brake adjustment.
- Simpler and easier shoe replacement.
- Equal distribution of shoe pressure for more positive braking.
- Self aligning shoes for even distribution of lining wear.
- Torque setting unaffected by lining wear. Built-in torque indicator.
- Cast-steel construction throughout.
- Nitralloy bushings with hardened pins.
- Captive hairpin cotter retainers at all pivot points.

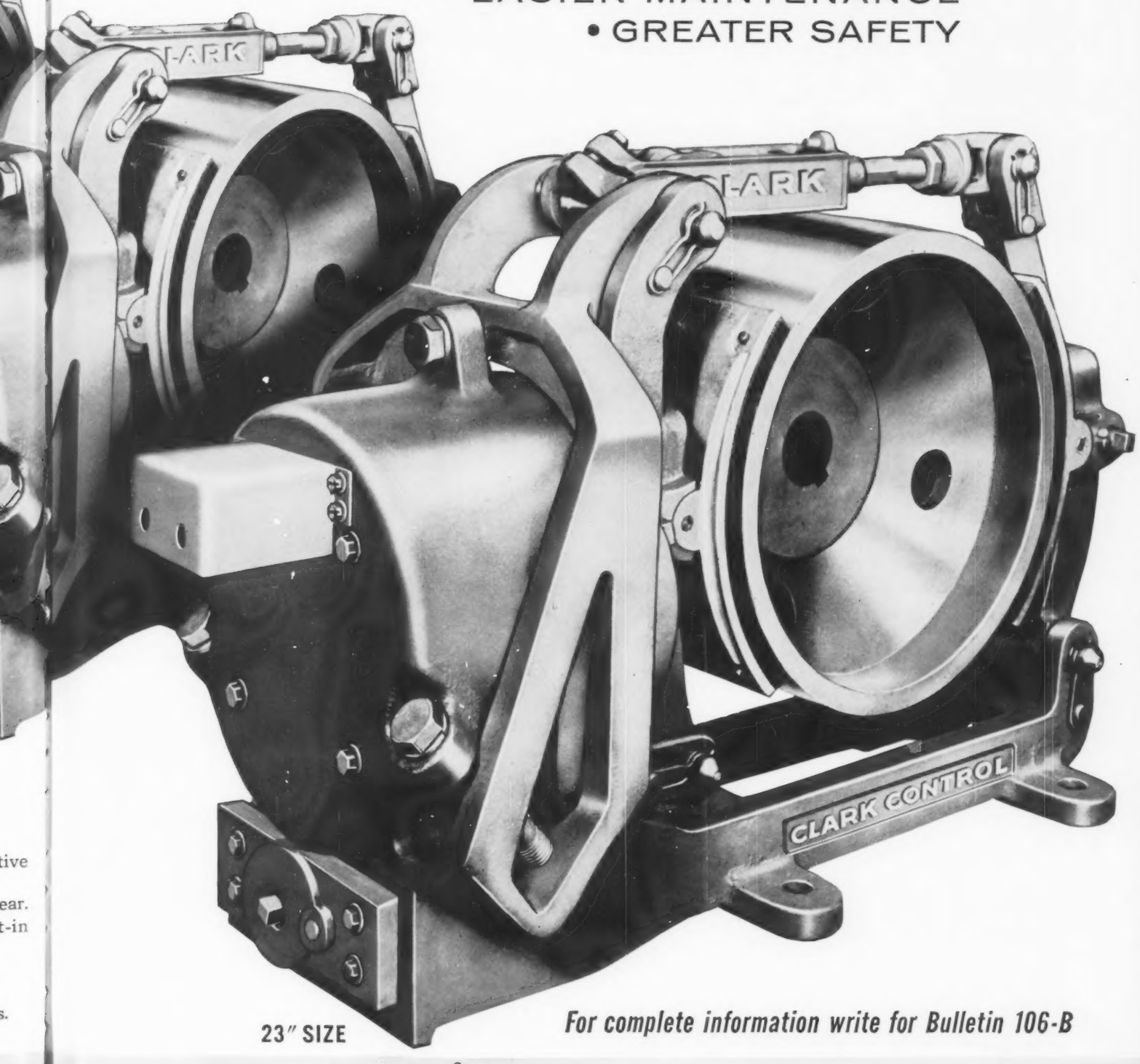
See the NEW CLARK BRAKES demonstrated at the IRON and STEEL SHOW

Cleveland Public Auditorium, September 23-26 . . . Booths 89, 90, 111, 112

LINE OF AISE-NEMA BRAKES

-with the proven CLARK "NUT-CRACKER" PRINCIPLE

- MORE DEPENDABLE OPERATION
- EASIER MAINTENANCE
- GREATER SAFETY



23" SIZE

For complete information write for Bulletin 106-B

The **CLARK CONTROLLER** *Company*

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

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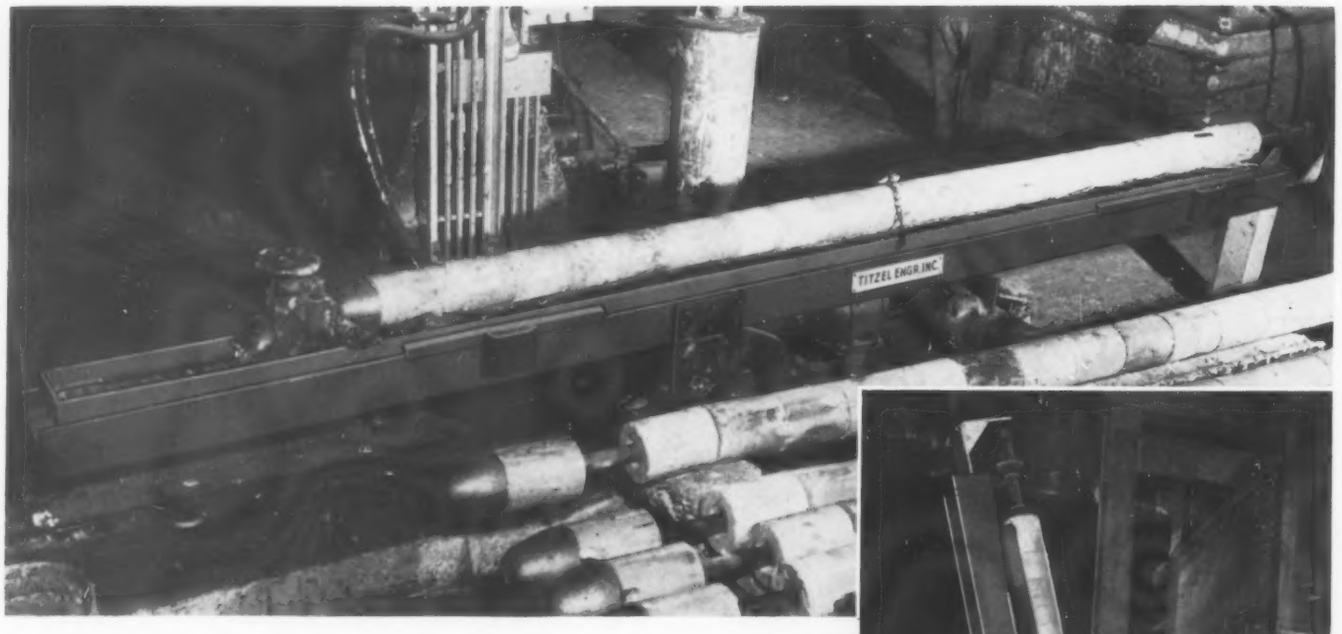
TITZEL

STEEL MILL EQUIPMENT



Mechanical Loading Unit for

STOPPER ROD DRYING OVEN-CONVEYOR TYPE

All the Way from Design to Installation

- JIB AND CASTING PIT CRANES FOR OPEN HEARTH DEPARTMENTS
- HOT TOPPING AND CAPPING CRANES FOR INGOT MOLDS
- JIB, PILLAR, WALL AND FLOOR TRAVELING CRANES
- BUTTON AND SKULL BURNING CRANES FOR SCRAP YARDS
- STOP ROD DRYING OVENS
- HYDRAULIC DESCALING SYSTEMS
- MILL SCALE HANDLING SYSTEMS
- PALM OIL SYSTEMS
- MILL DUST HANDLING SYSTEMS
- PNEUMATIC AND MECHANICAL CONVEYORS

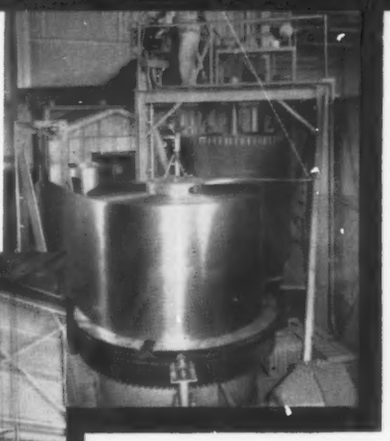
• DESIGNERS & MANUFACTURERS OF SPECIAL EQUIPMENT

TITZEL *ENGINEERING, INC.*

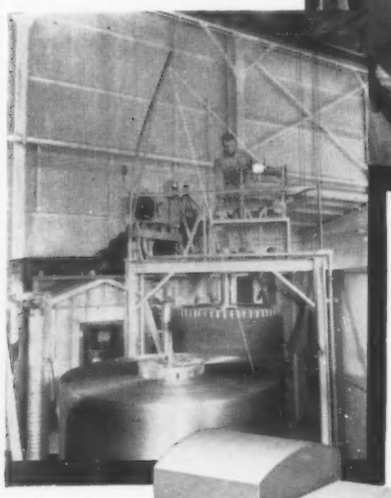
PITTSBURGH 22, PA.

Allied Company, Titzel Engineering and Equipment Co.

Stopper Rod Tilting and Lifting Unit for Placing Stopper Rods on Titzel Oven-Conveyor Type. Increasing Rod Life and Eliminating Cracks in Seams.

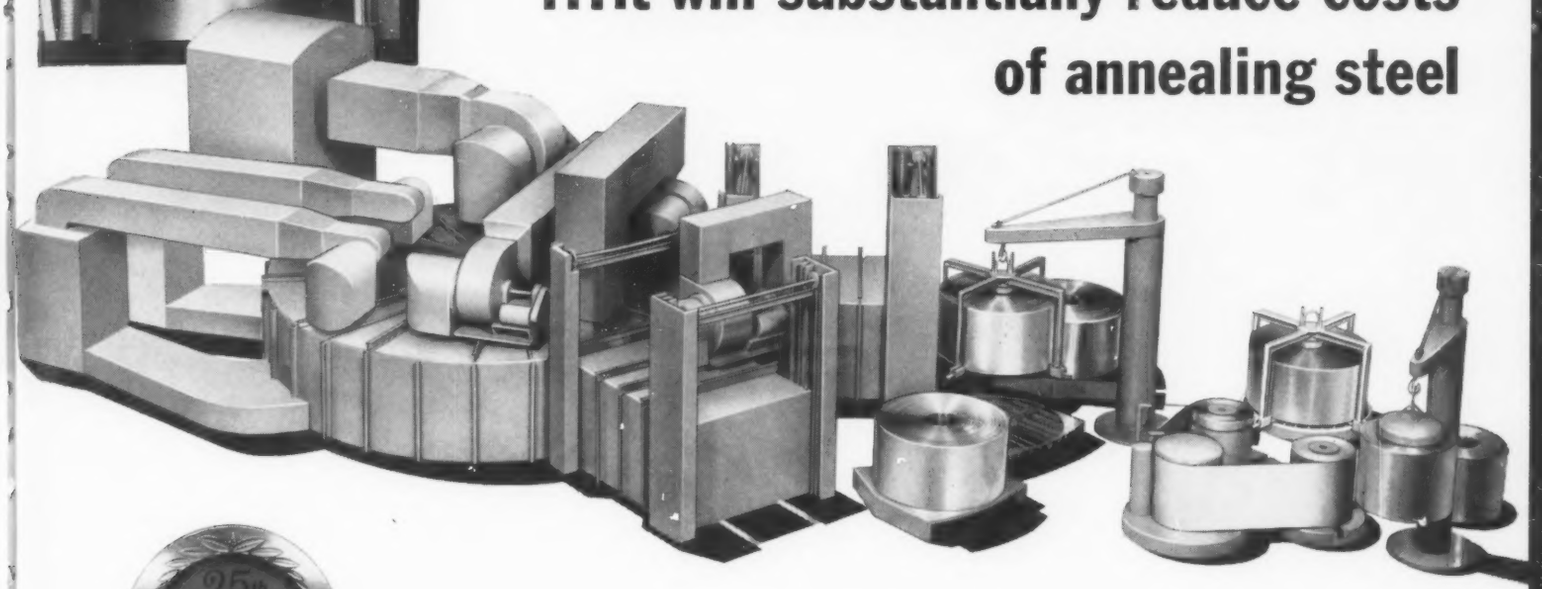


Right—Tight coil being opened. Note separator string being threaded into the coil.
Below—Separator string being removed from coil.



here it is...

the revolutionary opened coil annealer, designed by Lee Wilson ...it will substantially reduce costs of annealing steel



25th Lee Wilson ANNIVERSARY ENGINEERING COMPANY INC. CLEVELAND

Methods of opening and handling opened coils, heart of New System

Lee Wilson engineers have developed a method for opening and handling opened coils that makes it possible to expose from 200 to 1000 times the area to heat. This means a faster, more uniform anneal. The new system, further, drastically reduces the expensive process inventory required in the annealing operation. There are many other important advantages to this revolutionary new system. Be sure you have all the facts. Write today for your copy of the Opened Coil Annealer brochure that explains the system in detail.

Opened coil being rewound into a tight coil after annealing.

2505

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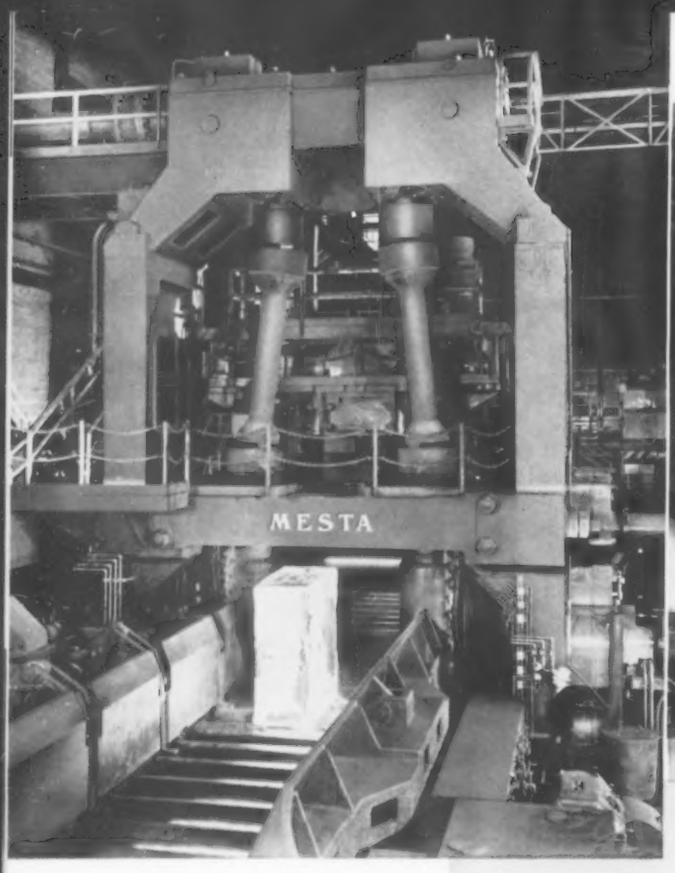
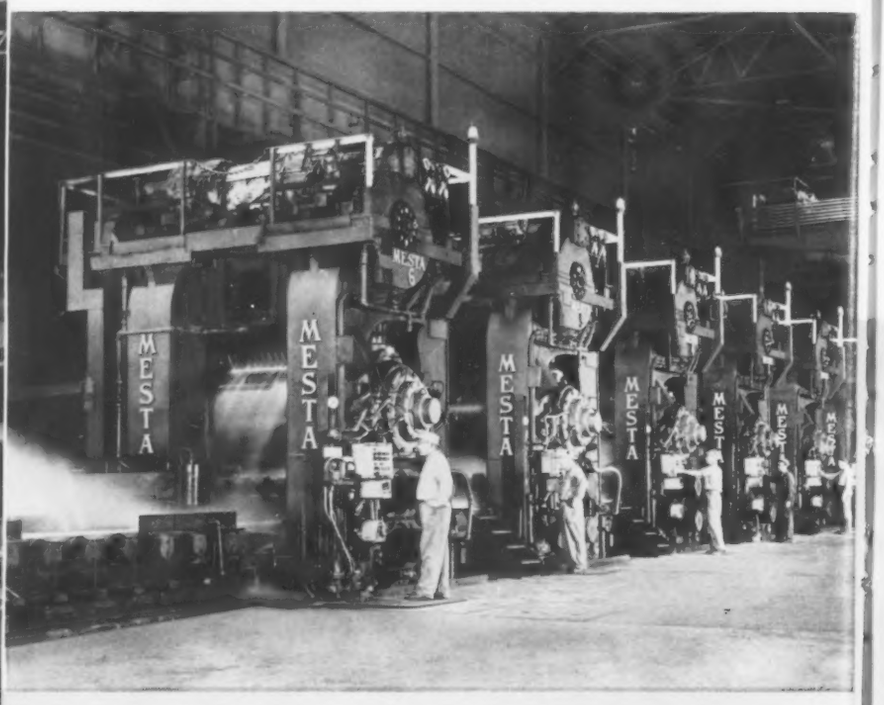
HIGH PRODUCTION ANNEALING SYSTEMS
MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES

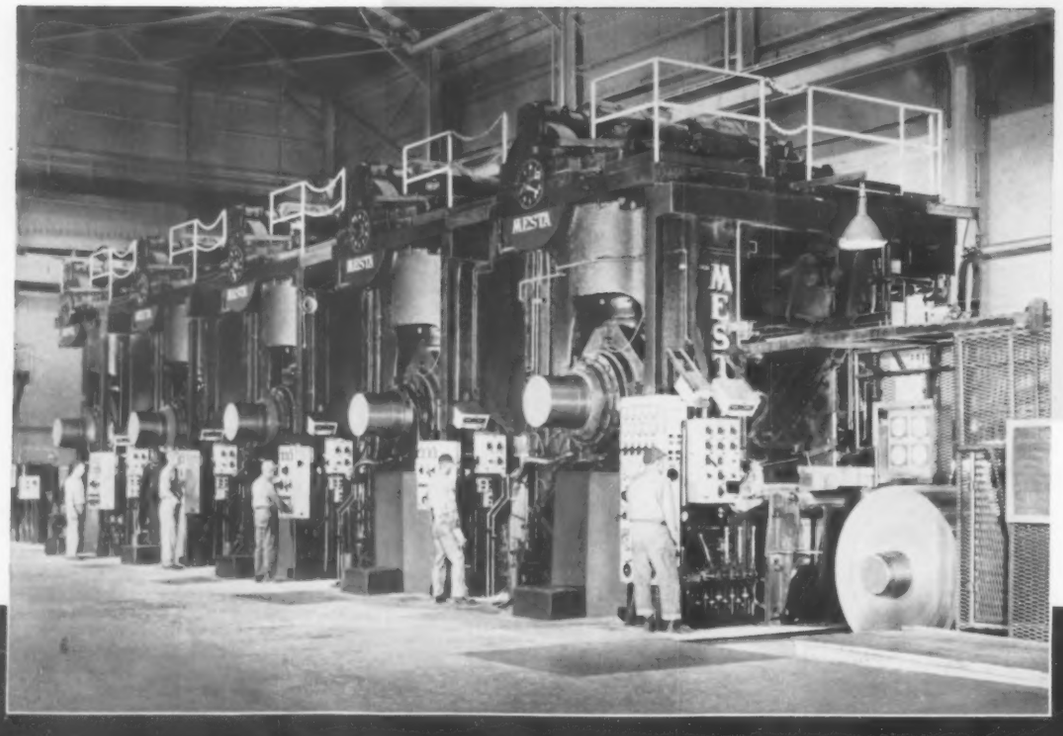


Rolling 20 Ton Ingots into Slabs on a MESTA 45″ x 90″ Universal Reversing Slabbing Mill

MESTA 60″ Four-High Hot Strip Mill Finishing Stands



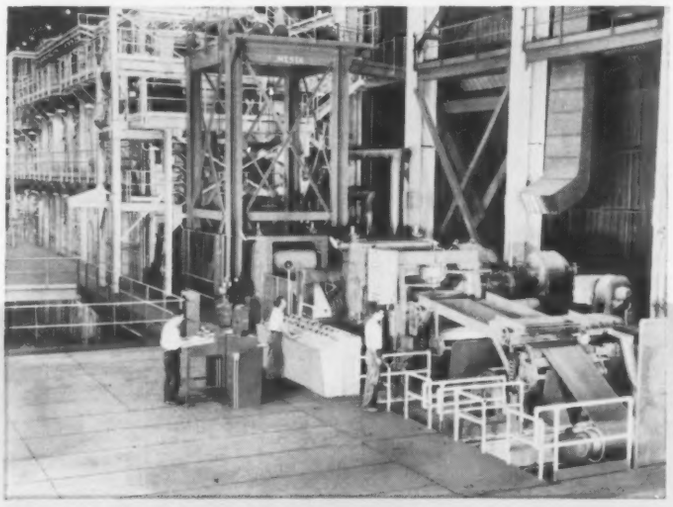
MESTA

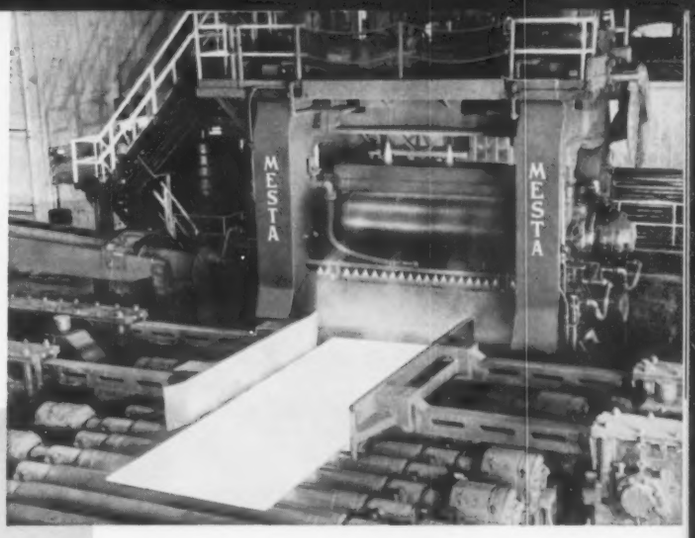


MESTA 48″ Four-High Five Stand Tandem Cold Mill Rolling Strip Steel for Tin Plate in Coils

MESTA
THERE IS NONE BETTER

MESTA 2000 FPM Continuous Cleaning and Annealing Line for Steel Strip in Tin Plate Gauges with Pay-Off Reels, Mash Welder, and Tension Reels





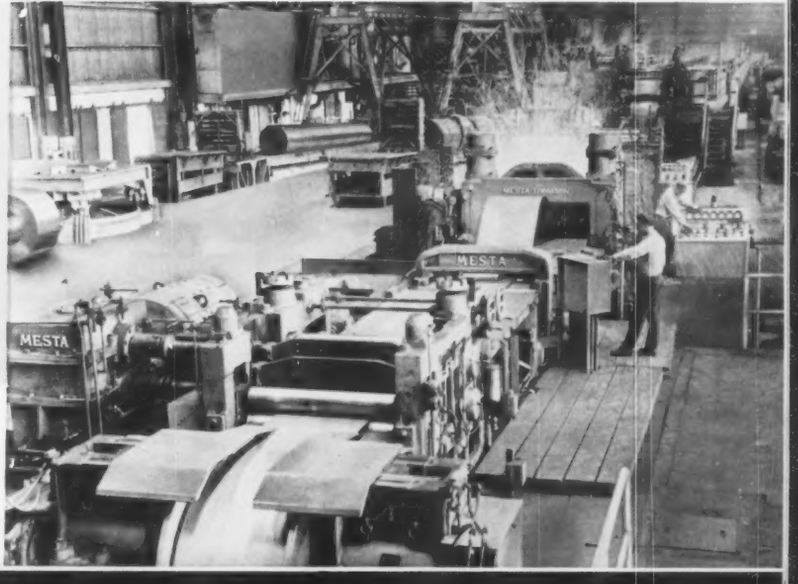
MESTA 160″ Four-High Reversing Plate Mill

Two MESTA 48″ Continuous Galvanizing Lines with Feed Reels, Straighteners, and Mash Welders

MESTA 60″ Sheet Shearing Line with Trimmer and Combination Rotary Flying Shear and Leveller

Designers and Builders of Complete Steel Plants

MESTA 48″ Continuous Pickling Line with Primary and Secondary Processors, Flash Welder, Up-Cut Shears, Side Trimmer, and Up-Coiler



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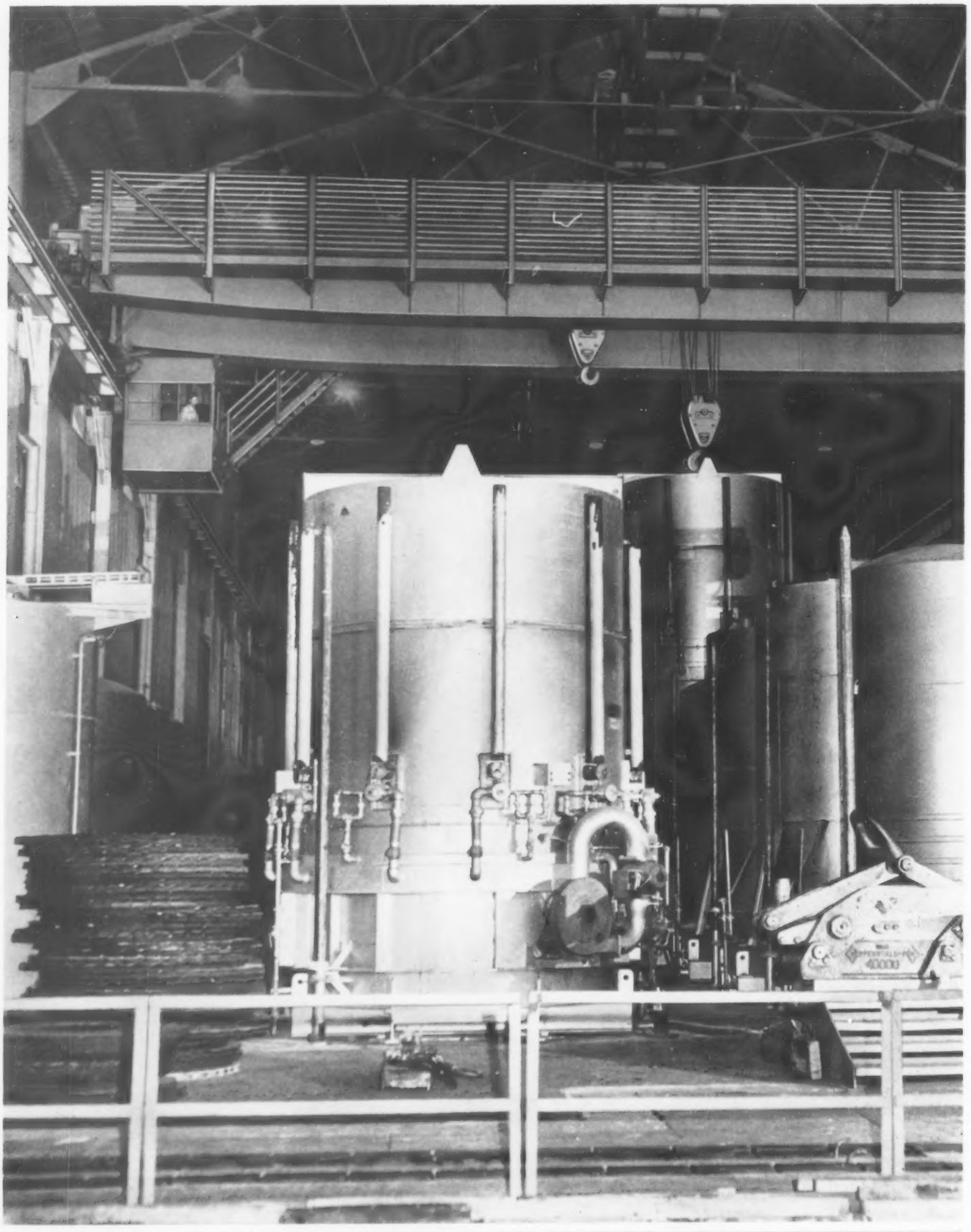
PITTSBURGH, PENNSYLVANIA

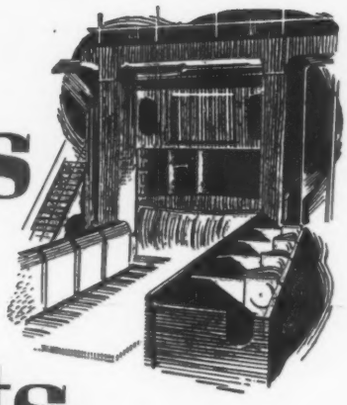


CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

THE CLEVELAND CRANE & ENGINEERING CO.
5031 EAST 289th STREET • WICKLIFFE, OHIO

Crops and Shorts



△ Just by way of a reminder, don't miss the Annual Convention and Iron and Steel Exposition in Cleveland, September 23, 24, 25, 26—fifteen fine technical sessions and an Exposition of greater area than ever before.

See you there.

△ It's a peculiar sort of recession we're having. It hurts in spots, yet our unemployment is less than twice the figure that we always have. Unemployment attributable to the slump is less than five per cent of the lowest employment total during this recession. Gross national product for 1958 is now estimated at only two per cent below that of 1957. Profits are down, varying with the type of industry, but are generally within the four or five best years. Personal income is closely approaching its previous peak. Savings have risen to a record high.

As we said, it's a peculiar sort of recession we're having.

△ Inflation, which has been termed the cruelest kind of tax, can be avoided, according to the Committee for Economic Development, if we give up "the illusion that we can get more out of the economy than we put into it, that we can consume more than we produce."

In a recent booklet titled "The Cruelest Tax," CED states that the responsibility for preventing inflation is a joint responsibility of government, business, labor and agriculture.

President Eisenhower recently indicated similar thinking when he said "I believe that labor, management and government must all be concerned . . . and of all these branches, no one could be more concerned than is labor." He added ". . . labor and business must be very, very careful about this whole problem of pushing wages each year above those rates that imply or show the increases in productivity, and business must make its profits of such a scale that, where they can still continue to invest money, they are not robbing the public . . . ."

It's a funny situation. Everyone agrees inflation must be stopped, but no one seems willing to do their part toward stopping it. Government, guided by expediency and politics, continues to spend us into deficits and higher debt. Labor, whipped on by ambitious union leaders, continues to use its monopolistic economic power to demand (and get) unjustified wage increases. Business feels that profits must be large enough to not only replace but also to expand its facilities.

Yes, everyone thinks it's wrong and somebody ought to stop it.

△ Other data released by the Committee for Economic Development showed that in the decade between 1947 and 1957 hourly compensation in all private industry rose about 70 per cent, while productivity went up only about 28 per cent. Due to the gain in productivity, however, unit labor costs rose only 33 per cent. To cover increased cost, prices rose 32 per cent.

In this same period, private purchases rose 71 per cent, while government purchases tripled.

△ The Wall Street Journal observes: Money still talks but you have to increase the volume if you want to get the message through.

△ Beer cans now account for about 78,000 tons of tin plate per month, and are used for 36.8 per cent of packaged beer sales. Monthly consumption for cans for other products run approximately 84,000 tons for fruits and vegetables, 25,000 tons for evaporated and condensed milk, 16,000 tons for coffee, 13,000 tons for pet food, 10,000 tons for meat, 37,000 tons for all other foods and 4500 tons for soft drinks.

△ We read someplace or other that automobile designers are striving to make future new models look less bulky. Wonder if they thought of just making them smaller.

And just to be fair, we should report that the villain in the automobile muffler situation is not the auto industry but the oil industry, which has been doctoring gasoline with additives which form acids in the exhaust. So now it seems that mufflers will be made from steel coated with aluminum or zinc.

△ Alaska's admission to statehood has brought on a rash of wisecracks. An Alaskan's definition of claustrophobia is what an Alaskan gets in Texas. But a Texan counters: Of all the states, Texas has the most land—not covered by snow.

△ Republic Steel's Warren blast furnace, with a 28-ft diameter hearth, set a new corporation record in July at 65,755 tons of iron.

△ The Value Line Investment Survey sees the decline in capital spending about over but the machinery industry appears to be headed for no more than a gradual recovery over the next year or two.

The Survey states that unrest in the Middle East, accelerated Federal spending, whittled-down steel inventories and the prospect of a sharp rise in durable goods sales add up to the probability of a strong revival in steel production extending into the early months of 1959. It estimates 1959 steel production at 111,000,000 tons.

△ The Labor Law Journal says: "A century ago a man worked 70 hours a week and had an average life expectancy of 40 years. The figures today are exactly reversed. Today a man works 40 hours a week and has a 70-year life expectancy."

Now let's see—if we didn't work at all, would we live forever or would we starve to death?

SEE THE NEWEST AT

Taylor Instrument Companies will present

an Advanced Showing of a new line of

ELECTRONIC

INSTRUMENTS

as well as the latest advancements

in pneumatic instrumentation

. . . at the ISA

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THE TAYLOR BOOTHS

The new line embodies the latest concept in electronic instrument design, while incorporating many time-proven convenience features originated by Taylor, such as front adjustment, plug-in components and truly rectilinear charts.

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Plus the SENSAIRE* Temperature Transmitter — hailed as an outstanding development in more economical pneumatic instrumentation.

Key representatives from our Application Engineering and Sales Departments will be on hand at the Show to counsel you with your instrumentation problems. And if you have branch plants overseas, you will be interested to learn of Taylor's recently expanded facilities — and our plans for further expansion.

Taylor Instrument Companies, Rochester, N. Y.,
and Toronto, Ontario.

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Furnace performance

proven in leading steel p

HAZEN *Metallic* Recuperators

increase tonnage and fuel economy in these applications

Blast Furnaces
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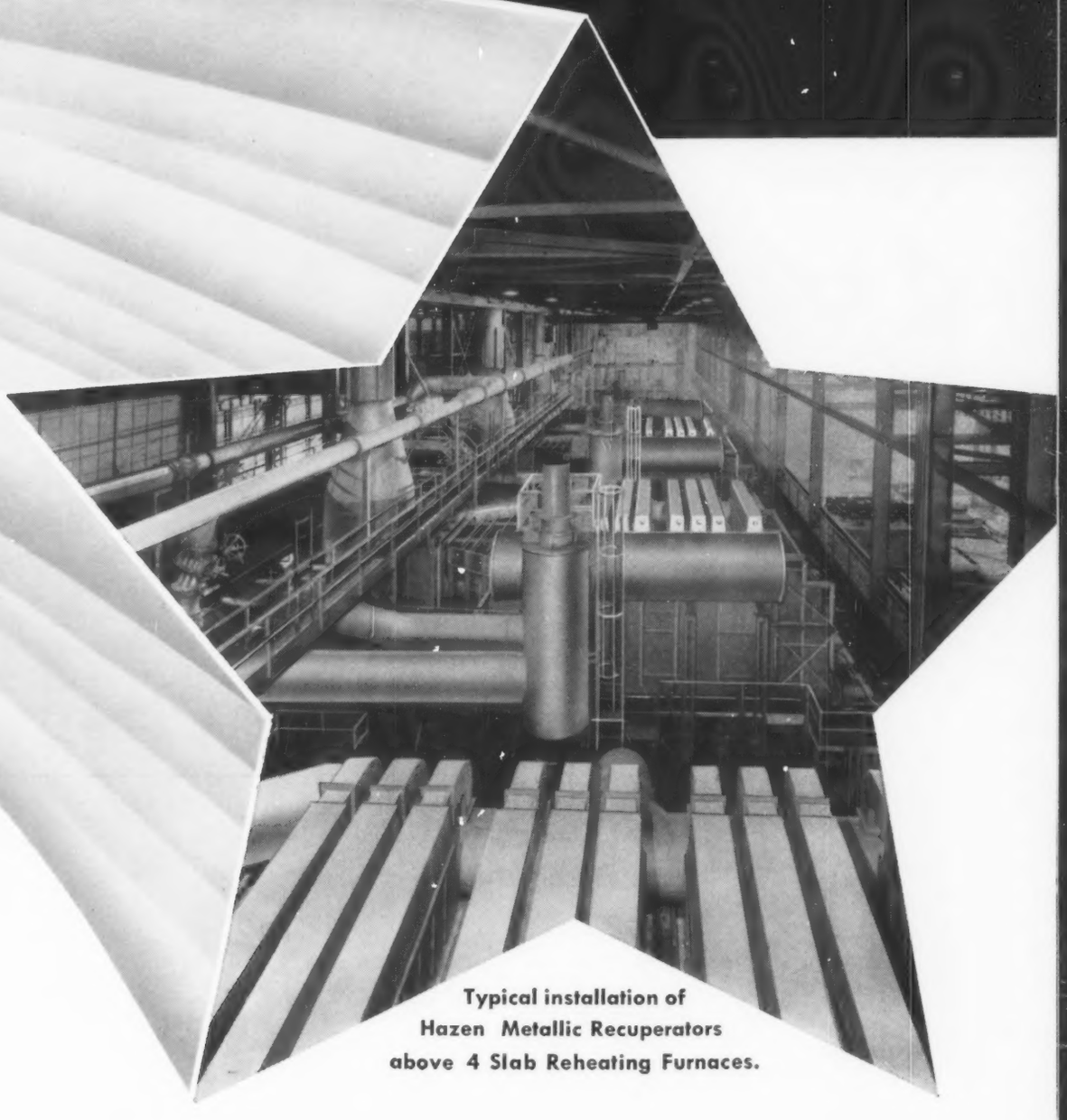
Soaking Pits
Reheating Furnaces
slab, bloom, billet,
Other Furnaces
metal treating, processing

Your mill capacity depends on furnace capacity. Increase it by hitching your furnace to the star of furnace accelerators—HAZEN . . . It's the only metallic recuperator with a long proven record of dependable performance.

America's Only Designer-Manufacturer of Metallic Recuperators Exclusively

e "out of this world"

plants



Typical installation of
Hazen Metallic Recuperators
above 4 Slab Reheating Furnaces.

- Star performer in boosting mill capacity through furnace acceleration
- The only 100% American Metallic Recuperator . . . inner and outer tubes made of stainless steel.
- Top Value—not by first cost alone but in terms of longer usage life and greater economy of furnace production.
- The Recuperator responsible for changing the trend in the steel industry from refractory to metallic design.
- The Recuperator that provides maximum preheat in keeping with the great longevity of the metallic elements.
- Designed to meet the most severe flue-gas temperature conditions . . . controlled automatically.

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HAZEN
the Pioneer in
Metallic
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184 Sandy Creek Road (Penn Hills) P.O. Box 10597, Pittsburgh 35, Pa.

Telephone CHurchill 2-1750

Q: Where would you look for *Air Products* in this picture?

A: Almost anywhere, in a steel mill.

(Aside from providing the best supply systems for oxygen and other gases, Air Products contributes to steelmaking technology as well.)

Air Products Applications Engineers may be found anywhere in a steel mill. They're hard to pick out because they look like—and are—steel men themselves.

- You may find them in the blast furnace area. *Air Products* oxygen has been used to enrich blast furnaces for over seven years.
- And you'll find them on the open hearth floor, helping to get more tons per hour from furnaces, through startling new practices. They started working with combustion oxygen in 1945 and with roof jets in their earliest stages of development. Current advances in this area at mills served by *Air Products* are helping to raise industry standards on almost a monthly basis.
- If it's an oxygen converter shop, odds are better than even that you'll find *Air Products* there. Many of their innovations have contributed to the growth of converter progress.

Although *Air Products* has changed oxygen from a costly specialty to a basic utility, the story doesn't end there. *Air Products* "steel men" are on the job around the clock . . . to help you increase production and make better iron and steel at less cost.

for open hearth oxygen applications
for all oxygen converter processes
for blast furnace oxygen enrichment
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NEW WELDCO Pipe Testing Machine

FAST *Tests up to 1000 pieces per hour*

WELDCO Installation in the St. Henry Works of The Steel Co. of Canada, Ltd.

WELDCO Automatic Pipe Testing Machines test up to 1,000 pieces of pipe per hour . . . 1/2" through 4" in single, random lengths.

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- Controls are all on one panel—for convenient, fast operation.
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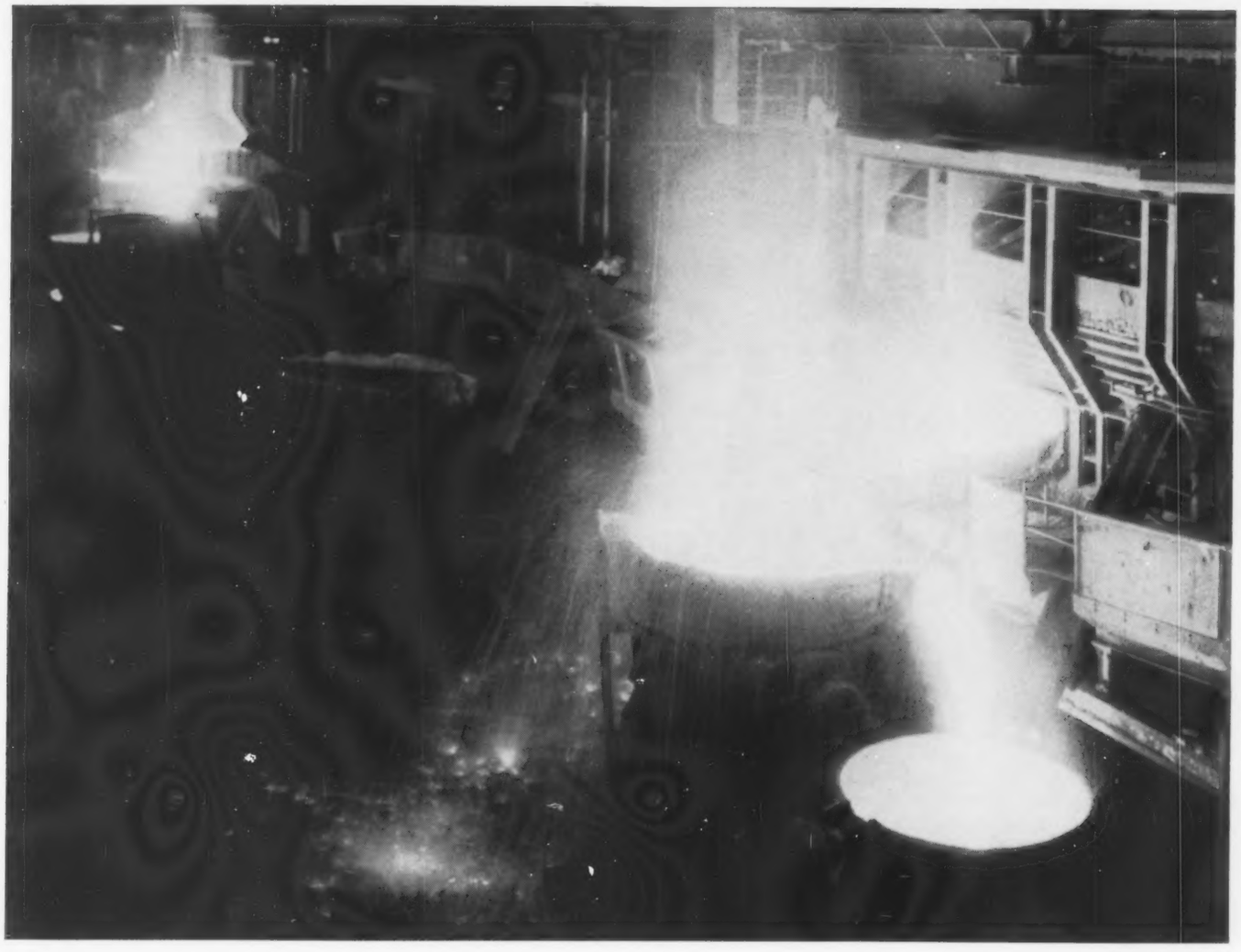

Increase production of your existing open hearths

We concur with the opinion of many steel plant operators that modernization of existing open hearth facilities represents an economical and often overlooked way to materially boost annual tonnage—with a minimum capital investment.

The required modification of present furnaces to assure a substantial increase in production involves a thorough design study—not only of hearth size or capacity, but also with respect to all other essentials of furnace structure from burners to stack. We have successfully completed a great number of such projects, and will welcome an opportunity to make a complete review of your steelmaking facilities.

From first heat to heat treat, look to **LOFTUS**
Engineering Corporation
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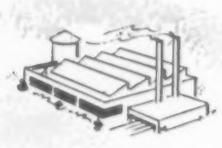
These Rust-Oleum differences

SAVE TIME, MONEY, METAL!

Here are just a few of the many Rust-Oleum differences that save *time, money, metal*—and help to make present equipment last longer.

Saves money—because the Rust-Oleum 769 Damp-Proof Red Primer goes right over sound rusted surfaces after wirebrushing rust scale and loose rust away—usually eliminating costly surface preparation. So easy to use that one man often does the work of two. *Saves money, too*—because Rust-Oleum provides approximately 30% more coverage than most ordinary materials, depending upon the condition and porosity of the surface. *Saves metal*—because Rust-Oleum's specially-processed fish oil vehicle penetrates rust to bare metal, driving out the air and moisture. Attractive Rust-Oleum finish coatings provide lasting beauty in the color of your choice.

See *proof* of performance with your own Rust-Oleum Test Sample. See its smooth, self-leveling action . . . see how you can save rusted metal and beautify as you protect. Your letterhead attached to the coupon on the opposite page will bring your FREE Test Sample. We want you to try it yourself under your own rust-producing conditions. One brushful tells more than a thousand words.



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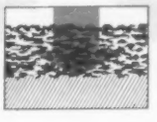
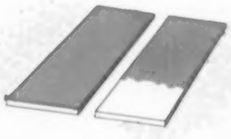
AVAILABLE IN PRACTICALLY ALL COLORS

EASILY APPLIED BY BRUSH, SPRAY, OR DIP



PENETRATES RUST TO BARE METAL



UP TO 30% GREATER COVERAGE

ONE MAN OFTEN DOES THE WORK OF TWO

STRETCH MAINTENANCE BUDGETS SEASON-TO-SEASON

UTILIZES SPECIALLY-PROCESSED FISH OIL VEHICLE

RUST-OLEUM®

Distinctive as your own fingerprint.
Accept no substitute.

STOPS RUST!®

Prompt delivery from
Industrial Distributor stocks.

CUT MAINTENANCE COSTS ON METAL SASH
Condensation damage! One of the biggest metal sash maintenance problems can be stopped with Rust-Oleum! Another place where lasting protection cuts costly, tedious maintenance to the bone.
LASTING BEAUTY FOR YOUR WATER TANKS
Rust-Oleum cuts tank maintenance two ways: (1) It eliminates costly surface preparation; (2) it lasts and lasts, in your choice of colors, for over-the-years protection against sun, fumes, moisture, heat, weathering.
SAVE UP TO 40% ON FENCE RE-COATING
Extra-Long Nap Lamb's Wool Roller coats approximately 70% of opposite side of fence in same operation. Easy-flowing, penetrating Rust-Oleum works around wires for smooth coverage—no "holidays."
ATTACH THIS COUPON TO YOUR BUSINESS LETTERHEAD FOR FREE TEST SAMPLE
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Please send me the following information about Rust-Oleum, at no cost or obligation:
☐ Free Test Sample of Rust-Oleum 769 Damp-Proof Red Primer.
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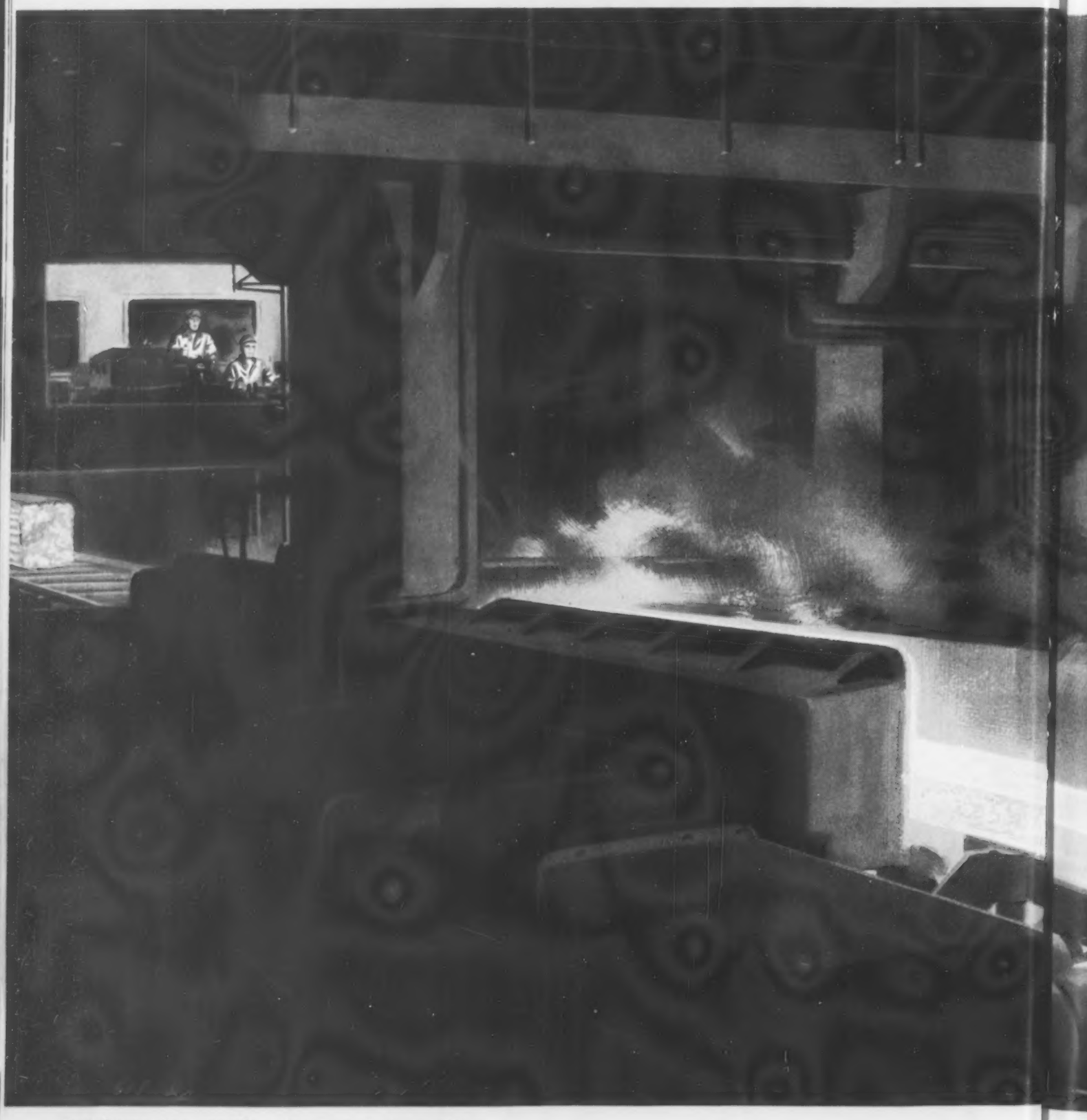
ALLIS-CHALMERS . .



Products for steel: motors, m-g sets, rectifiers, control, pumps, *Texrope* drive equipment, crushers, grinding mills, screens, transformers, unit substations, switchgear, circuit breakers, turbine-generators, voltage regulators, blowers, compressors, condensers, and water conditioning equipment.

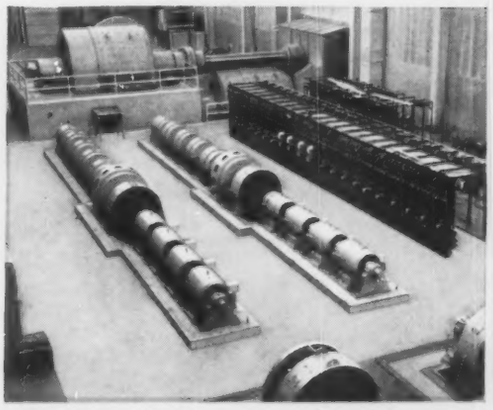
ALLIS-

in Step with STEEL

The blooming mill

Maximum electrical efficiency is assured in blooming mill operations where Allis-Chalmers equipment is used. From switchgear to drive motors, Allis-Chalmers offers a tailored system — engineered by mill experts and designed to keep high quality blooms rolling fast and accurately.

From mine to final processing—Allis-Chalmers equipment is in step with the increasing tempo of expanding steel production. Contact the nearest A-C office in your district, or write Allis-Chalmers, Milwaukee 1, Wisconsin.



Blooming mill motor room view shows components of the Allis-Chalmers electrical package. Switchgear, control, constant and variable voltage motor-generator sets, *Regulex* motor-generator sets, liquid rheostat, and twin drive motors are designed to work together for peak mill output.

Regulex and *Texrope* are Allis-Chalmers trademarks.

CHALMERS

A-C ALLIS-CHALMERS

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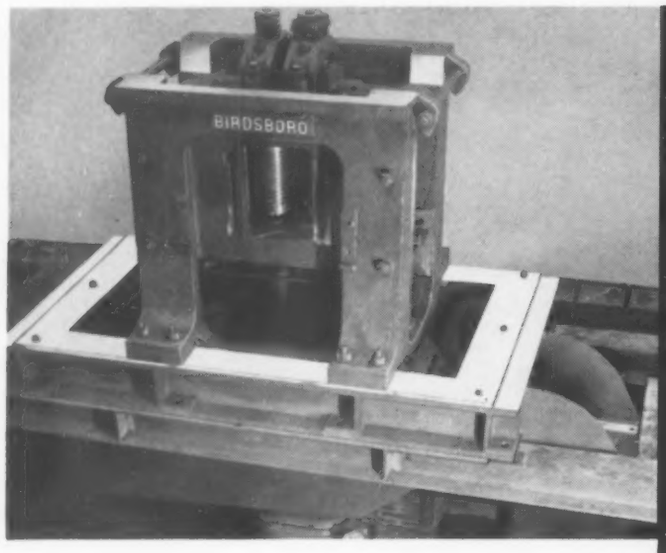

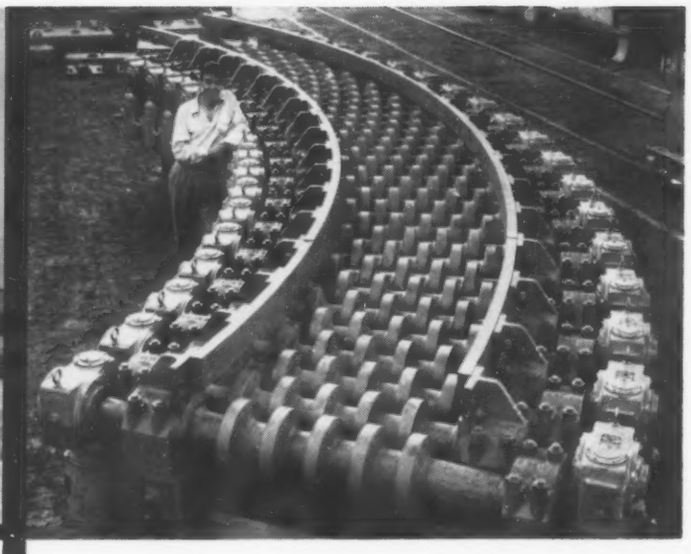

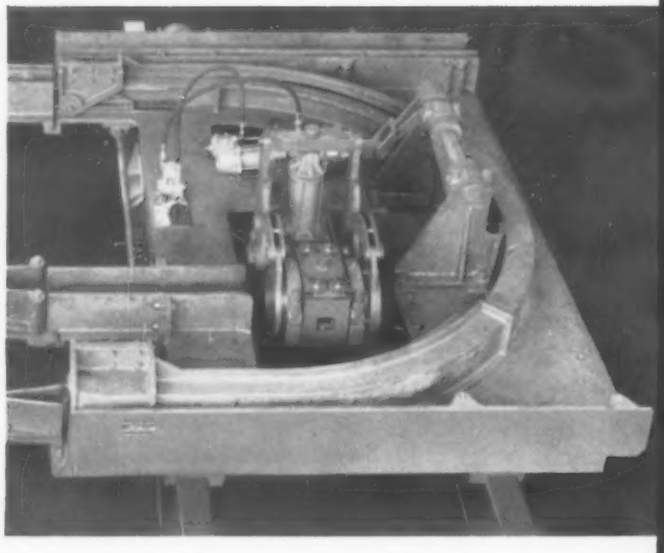

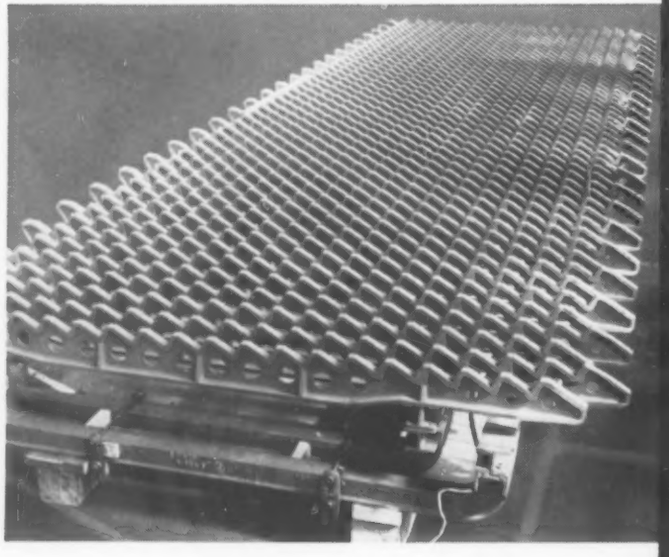

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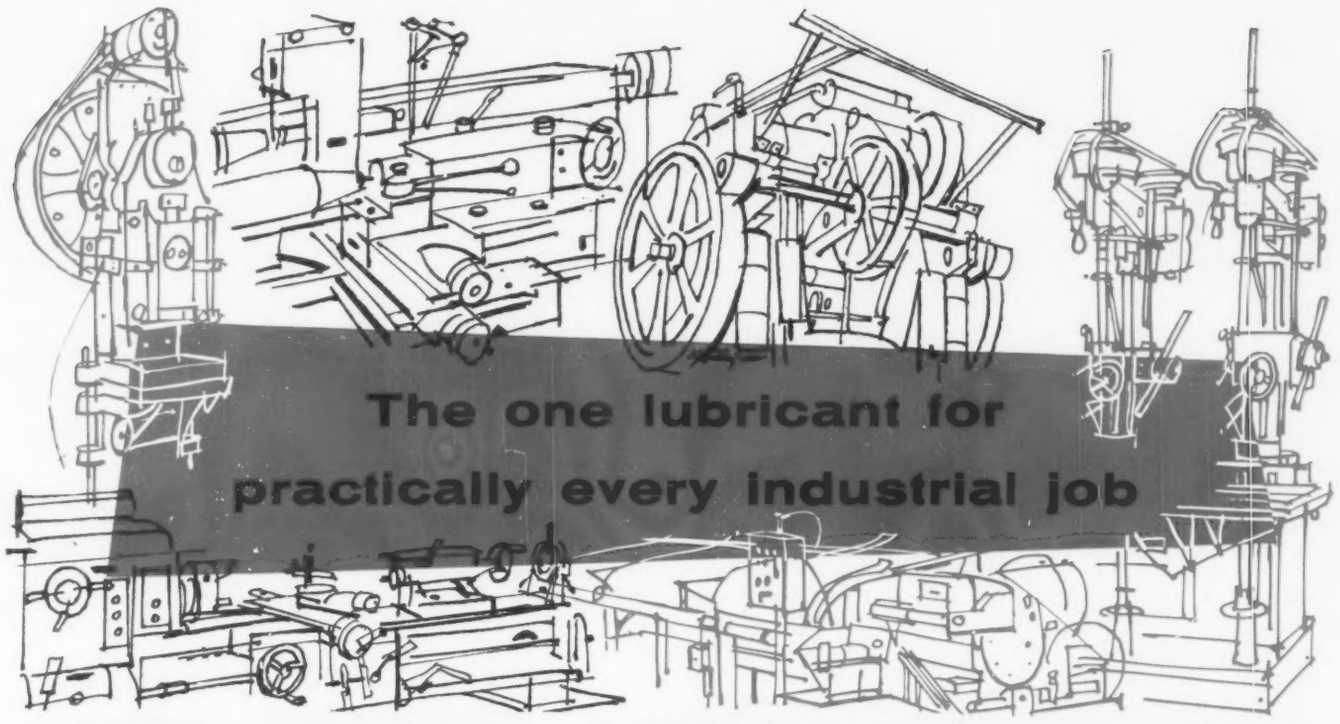

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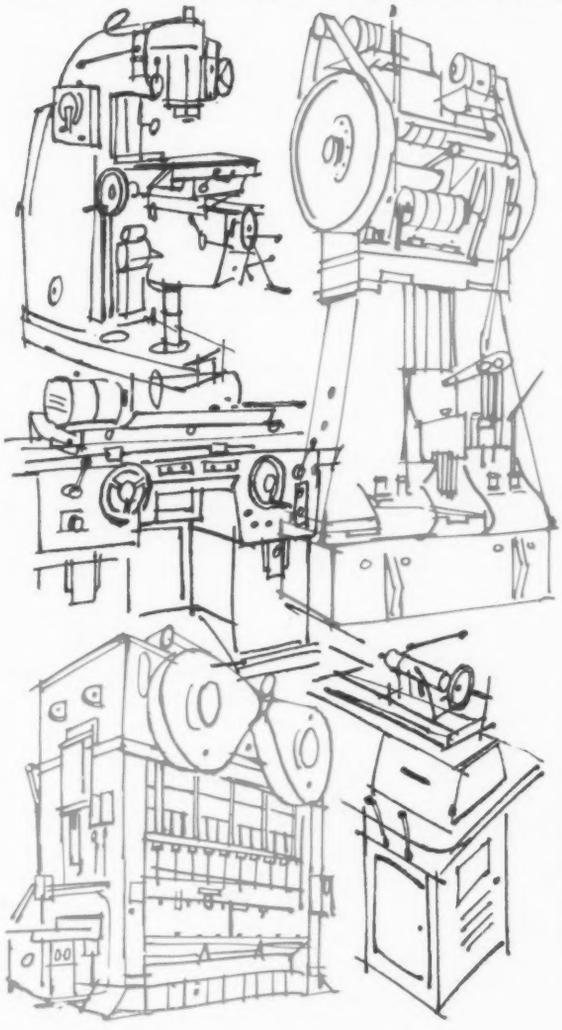
Performs on all types of grease-lubricated machinery • Cuts cost • Reduces lubricating errors



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J & L HAD A PROBLEM:

17 cinder cars needed...to meet a deadline

TREADWELL SOLUTION:

17 cinder cars built and delivered...on time!

Blast furnace operation at the Cleveland Works of Jones & Laughlin Steel Corporation required that 17 cinder cars be built and delivered in a hurry.

By consulting with Treadwell engineers, J & L determined the type and capacity of cinder car best suited to their needs. A short-time delivery date for the 17 cars was agreed upon. The order was placed, *and all 17 cars were built and delivered as specified...in ample time to meet operating requirements.*

The J & L case is a good example of the obliging, experienced service you can expect from Treadwell. It shows why so many leading metal producers rely exclusively on Treadwell cars.

Established 60 years ago, the company has specialized in the design and production of cars and related equipment. More than 2000 cinder cars alone, have been placed in service in the United States, Canada and overseas.

Why not put this cinder car experience to work for you? Send for details. Ask for copy of bulletin 61.

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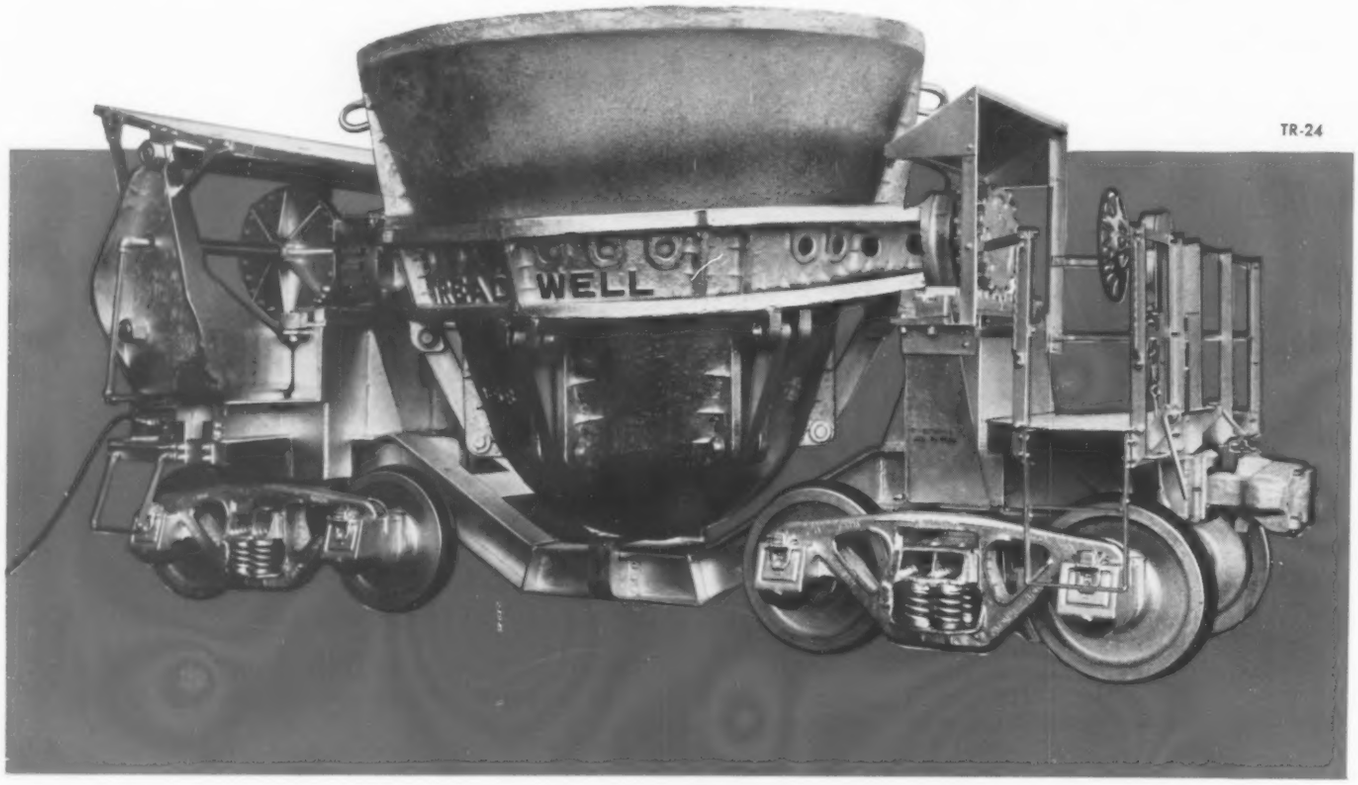
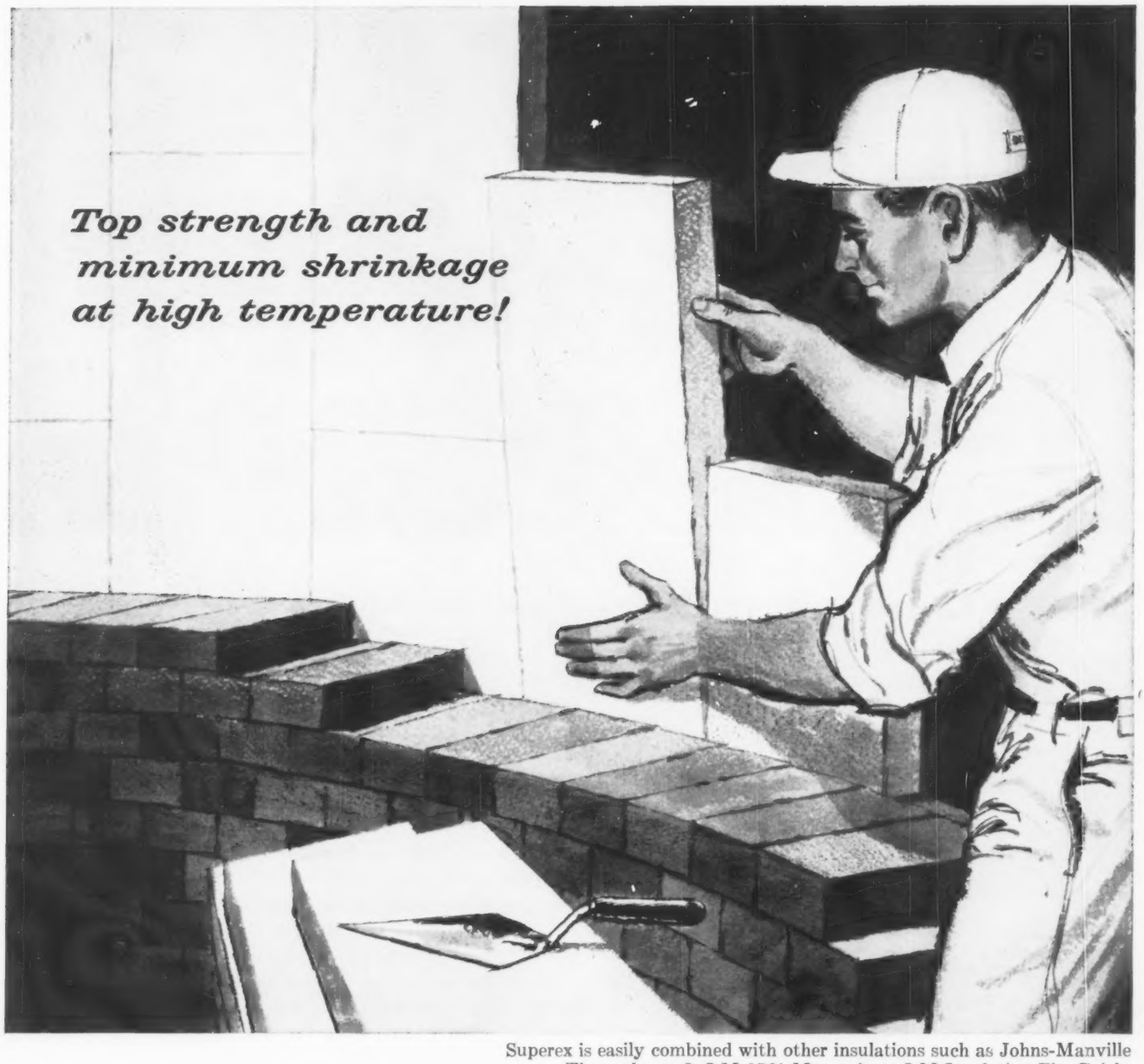


This 400 cubic foot cinder car is one of 17, built for Jones & Laughlin.

TREADWELL

CINDER CARS



Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

After a quarter century . . .

there's still no substitute for J-M Superex insulation for service to 1900F!

In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.

Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

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Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

MATERIALS • ENGINEERING • APPLICATION

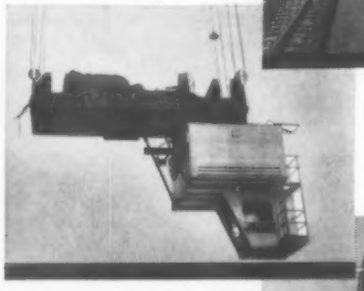
15-ton bridge for stocking and reclaiming ore at Eastern steel mill.

DRAVO heavy materials-handling equipment

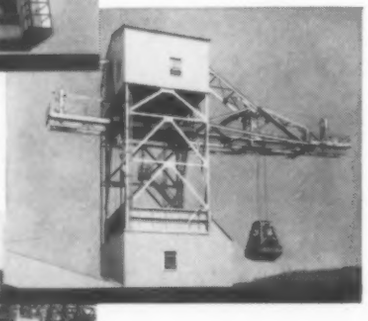
... *custom built for you!*

Traveling unloaders built to handle imported ore at an Atlantic port.

Two bridges for unloading, stocking and reclaiming ore at Great Lakes steel mill.



Light-weight man trolley installation increased bridge handling capacity 60%.



Coal unloader designed and built for a large mid-western electric power company.

Unloading ore boat at Lower Lakes port.

Over-all economy and safe performance are best obtained by using materials-handling equipment designed to suit your operating conditions. If you're planning a new materials-handling installation, we suggest an early "Round Table" session with Dravo engineers.

From actual experience in building and installing the type of equipment shown here, valuable know-how is available in working out features needed in your installation. This knowledge, along with your own operating experience, can be used to create a design incorporating all the best features for easy maintenance, a high safety factor, and simple, economical operation.

For complete information write DRAVO CORPORATION, NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA.

DRAVO
CORPORATION

Find out more about Dravo materials handling, sintering, pelletizing and beneficiation equipment. Visit Dravo at the Iron and Steel Exposition, Cleveland, September 23-26.

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period April 8, 1958 through April 29, 1958.

OXYGEN LANCE

▲ U. S. 2,829,960, issued April 8, 1958, to William A. Vogt, assigned to Henry J. Kaiser Co., describes a lance, for use in oxygen converters, which is designed to simultaneously displace the slag from the area of oxygen contact, and to bring about the contact of the oxygen and metal at the cleared area. An advantage of the device is that it enables blowing with oxygen at lower velocities, thereby avoiding local overconcentration of oxygen and excessive local heating and, as a consequence, the production of oxidized iron particles is reduced.

As shown in Figure 1, a slag-displacing medium G, which can be

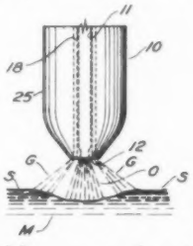


Figure 1

steam, carbon dioxide, or an inert gaseous substance, is forced through an outer channel 18 of the lance with sufficient pressure to displace the slag S and expose the surface of the hot metal M, immediately below the lance, and prepare it for impingement by the oxygen jet O from the central pipe 11 through the nozzle 12.

TREATING CONVERTER WASTE GASES

▲ U. S. 2,831,762, issued April 22, 1958, to Roland Kemmetmuller and Rudolf Rinesch, assigned to Wagner-Biro A.G., et al., provides a method of treating converter waste gases.

The exhaust gases leave the mouth of the converter at temperatures between 1600 and 1800 C. After leaving the converter outlet, the solid particles are normally oxidized in the presence of an excess of air to form mainly Fe_2O_3, which causes the intensive red coloring of these particles. The exhaust gases from converters operating on air or oxygen contain nitrogen which retards the oxidation to Fe_2O_3 so that in these plants the escaping particles do not, or only at a later time, disintegrate to Fe_2O_3. The particle sizes of the iron compounds FeO, Fe_3C and $FeCO_3$ are in the order above one micron. When these compounds are oxidized to form Fe_2O_3 they disintegrate to form particles smaller than one micron. This reduction in particle size renders the removal of these particles from the exhaust gases very difficult.

Plants have been constructed in which such exhaust gases containing these fine dust particles are conducted through gas cooling and cleaning plants. All these processes employ oxygen in a larger quantity than is necessary for the theoretical combustion of the CO gas escaping from the converter. This is the cause of the formation of Fe_2O_3, which involves the extensive red coloring of the escaping exhaust gases. The large excess of air also causes a considerable increase in the quantities of gas so that unduly large exhaust gas cooling and cleaning plants are required.

In the present invention, only enough air or oxygen is introduced into the exhaust gases to convert the carbon monoxide to carbon dioxide. In addition, the exhaust gas is immediately cooled to a temperature which is too low to permit the oxidation of FeO to Fe_2O_3. Thus, the exhaust gases contain only iron-carbon compounds or iron oxygen compounds of black or gray color, and with particle sizes much larger than that of Fe_2O_3. The removal of the dust is also facilitated by the decreased volume of exhaust gas.

METHOD OF CONTINUOUSLY ANNEALING STEEL STRIP

▲ U. S. 2,832,711, issued April 29, 1958, to Francis J. Krahe and Bernard M. Neckrich, assigned to United States Steel Corp., describes a method for continuously annealing cold reduced strip steel, particularly low carbon steel strip.

Flat-rolled low carbon, i.e., containing not more than 0.2 per cent carbon, steel represents approximately 50 per cent of the rolled steel produced. By far the largest portion of this product is reduced to final gage by cold rolling; gage-reductions as high as 85 per cent being made in the latter operation. The effect of such drastic cold

reduction is to elongate and mash the microstructure of the steel, rendering it hard and unformable and necessitating a subsequent heat treatment to restore the desired degree of softness and ductility. The aim of the treatment is to produce sheet or strip to a specified hardness value suitable for its ultimate use.

Heretofore the heat treatment has generally consisted of box annealing the cold-reduced strip. In this operation several coils are stacked in a suitable enclosure and slowly heated to about the lower transformation temperature of the steel, soaked at this temperature for several hours and then very slowly cooled to a temperature of about 250 F, the entire cycle requiring 60 to 70 hr. This treatment, when properly conducted, results in a microstructure of equiaxed ferrite grains characterized by distribution of the carbides as small well-rounded particles. Such structure is considered by many to provide optimum combination of softness and ductility and to be the best for severe forming operations. Box annealing, however, is a very time consuming operation and in recent years there has been an increased shift to the use of continuous annealing. In the latter operation, the steel is passed as a strand through a furnace comprising a heating and a cooling section. The heating section is designed to bring the steel strip to a temperature in the range of 1450 to 1750 F in ½ to 2 min and hold it in this range for several seconds; the cooling section is several hundred feet long and is arranged to counterflow cooled furnace atmosphere to bring the strip to the desired end temperature in a few minutes. Continuous annealing is well adapted to in-line-production of coated steel products since the strip can be cooled to a temperature just above the temperature of the coating metal and introduced immediately therein, thus affecting a considerable conservation of heat. Practice representative of conventional continuous annealing is depicted by curve 1 of Figure 2. While conventional continuous annealing practice is directed toward obtaining a fully annealed product, i.e., the steel strip is heated to temperatures approaching or above its upper critical, the operation will not

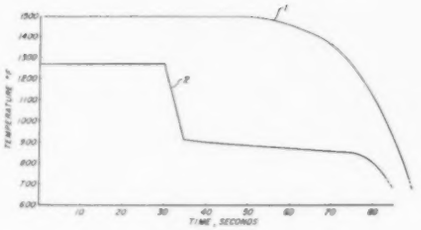


Figure 2

produce as soft a product as the older box annealing even when the strip speed is decreased to provide additional time at temperature.

The annealing practice disclosed in this patent is aimed at consistently producing soft strip, i.e., Rockwell B-55 maximum hardness, in continuous annealing furnaces at high speeds. It has been found that a particular subcritical annealing temperature range used in conjunction with a specific cooling and holding cycle will consistently produce the desired properties.

Annealing at subcritical temperatures is possible since ferrite grains, which have been distorted and highly stressed as a result of cold rolling, have the ability to recrystallize and reorient themselves into a normal structure at temperatures as low as 1000 F. However, the pearlite grains which have also been stressed and distorted by cold rolling remain unaffected at subcritical temperatues. The annealing practice of this invention is a departure from the recognized art in subcritical annealing, as is apparent from curve 2 of Figure 2.

SINTER TREATING APPARATUS

▲ U. S. 2,832,584, issued April 29, 1958, to Thomas W. Plante, relates to the treatment of sintered ore.

The heat of the discharged sinter presents a serious problem in the transportation of the sinter from the sintering machines to the furnaces in which the sinter is to be used, or to the usual storage site convenient to such furnaces. That is to say, it has been found that railroad cars, conveyor belts or other vehicles are damaged by the heat of the sinter. Furthermore, the smaller particulate material must be screened or sifted from the sinter for reprocessing, and during such operation fumes, smoke and dust are evolved, normally polluting the atmosphere of the locality in which

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,829,566	4/8/58	Indexing table	American Steel Foundries
2,829,713	4/8/58	Flying shear	Einar W. Nilsson
2,829,879	4/8/58	Bottoms for bessemer converters	Huettenwerk Haspe A.G.
2,829,963	4/8/58	Recovery of nickel from nickel and iron bearing ores	Bethlehem Steel Co.
2,829,995	4/8/58	Process for sulphide-coating ferrous alloys	Arthur D. Little, Inc.
2,829,996	4/8/58	Improving the machining qualities of steel	Bethlehem Steel Co.
2,830,467	4/15/58	Rolling mill inching device	Elliott Co.
2,830,701	4/15/58	Flexible billet container support for extrusion press	Baldwin-Lima-Hamilton Corp.
2,830,788	4/15/58	Apparatus for raising and lowering a marine vessel	United States Steel Corp.
2,830,806	4/15/58	Tuyere cooler	United States Steel Corp.
2,830,889-92	4/15/58	Production of ferromanganese	Udy Metallurgical & Chemical Processes Ltd.
2,830,897	4/15/58	High-silicon steel rails	The Colorado Fuel & Iron Corp.
2,831,759	4/22/58	Production of sponge iron	Phelps Dodge Corp.
2,831,761	4/22/58	Production of low-carbon ferrochromium	Walter M. Weil
2,831,814	4/22/58	Acid pickling bath	Poor & Co.
2,832,228	4/29/58	Apparatus for automatically centering a moving belt	United States Steel Corp.
2,832,401	4/29/58	Open hearth burner	Ernest E. Lail
2,832,585	4/29/58	Air cooled damper construction for foundry cupola cooling towers	International Harvester Co.
2,832,683	4/29/58	Production of cast iron containing about 2 per cent silicon	Buderus'sche Eisenwerke
2,832,708	4/29/58	Treating stainless steel to improve its corrosion resistance	General Motors Corp.

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- **Cold-rolling aluminum foil**

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the sintering plant is situated.

A common prior practice has been to cool the sinter by spraying or quenching it with water, but this has the disadvantage of deteriorating the product. Another prior method has been to cool the sinter moving on an endless conveyor, by passing air currents through the permeable mass of sinter on the conveyor. Due to the presence of the relatively fine particles in the mass of the sinter, however, the permeability of the mass to the flow of air is relatively low, with the effect that air under practical pressure, or draft, is unable to pass freely through the sinter at a rate which effects a cooling of the sinter at required rate.

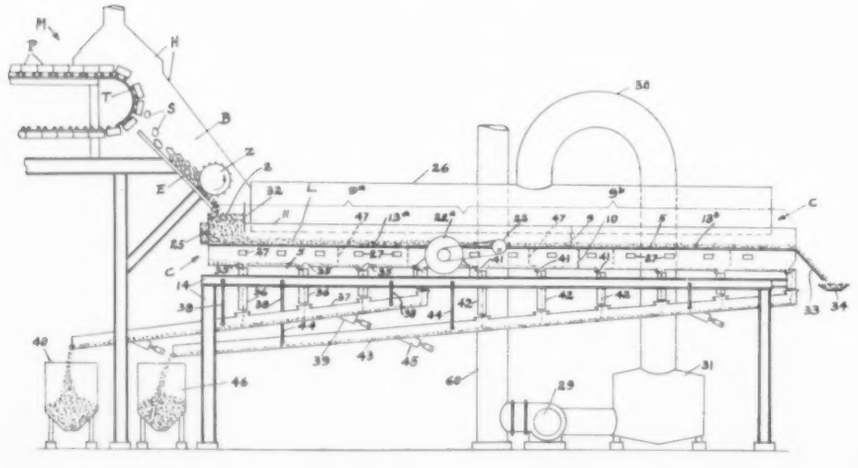
The object of the present invention is to increase the permeability of a mass of sinter to be cooled, and to cause ample quantities of cooling air, or other gas, to flow easily through the sinter and to cool it quickly and adequately.

In Figure 3, the discharge end of a continuous type ore sintering machine M carries the mixture to be sintered on the upper reach of an endless conveyor comprised of pans or pallets P. As the pallets P reach the discharge end of the machine, the sintered product S in each pan is dumped into a chute B, the inclined bottom of which is formed by a heavy steel plate E. The discharged masses of sinter (S) descend by gravity on plate E, and pass under the crusher Z into a hopper 2 at the intake end of the apparatus in which the invention is found.

The apparatus consists of a two-stage vibrating conveyor C, the upper stage 9 being directly above the lower stage 10. The conveyor is trough-shaped in section.

The vibrating conveyor C, due to the vertical and horizontal components of its vibrating motion, draws sinter S from the hopper 2 and advances the sinter in left-to-right direction on the grizzly screen (13a). The sinter passes beneath the lower edge of a vertically adjustable gate 32 that forms the forward wall of the hopper 2. The lower edge of the gate 32 serves to distribute the hot sinter, and to regulate the depth of the sinter layer L on the screen that forms the floor of the upper stage of the conveyor. The layer or bed of sinter advances along the screen (13a) and then along the screen (13b). The sinter is discharged upon a chute 33 to a belt conveyor 34. In the course of such vibrating advance of the layer L of sinter the unsintered and relatively fine particles are worked downwardly through the sinter layer L and drop through the screen bars 13a into the portion of the lower conveyor stage 10 that lies below the portion 9a of the conveyor. While this screening or sifting action occurs, air is drawn through the inlets 27, under the effect of the exhauster fan 29, and passes upwardly between the bars of the grizzly screen and through the permeable layer of sinter. The passage of the cool air from the outer atmosphere through the layer L acts to cool the hot sinter. As the sinter passes to and advances over the second support portion 9b, the coarser particles in the sinter layer are sifted downwardly between the more widely spaced bars 13b into the portion of the lower stage 10 below portion 9b, while the streams of cooling air pass upwardly through the sinter. The end of the lower stage 10 of the conveyor is open beneath the discharge chute 33, and air enters through such open end to supplement the air drawn in through the inlets 27 for cooling the sinter.

Figure 3



LADLE STOPPER CONTROL APPARATUS

▲ U. S. 2,832,110, issued April 29, 1958, to Richard J. Carleton, Jr., assigned to Blaw-Knox Co., describes a means for operating a power driven ladle stopper which can be controlled by an operator who may move about freely to observe the pouring from the best vantage point. The power apparatus includes a hydraulic system employing a non-compressible fluid, and the control means includes an electrical system for selectively operating the hydraulic system whereby the stopper may be moved to and maintained in any desired position within its operative range. The electrical system includes switch means which may be operated from a portable apparatus whereby the operator is free to move relative to the ladle and associated equipment.

Referring to Figure 4, a ladle 10 having refractory lining 11 is provided with a bottom orifice or nozzle 12. The nozzle is closed by a stopper 13 which may be formed of a vertical steel rod 15, having a tip 16 of refractory material and a number of refractory collars or sleeves 17 arranged in successive abutting or interlocking relationship with each other between the tip and a retaining nut 18, to provide the stopper rod 15 with a protective covering so that it will not melt when the ladle is filled with molten steel.

The upper end of the stopper 15 is provided with means for rigidly attaching a cross-head member 20. The cross-head extends outwardly beyond the lip 22 of the ladle 10 and has a slide or guide rod 23 rigidly fixed adjacent the end 25.

The slide rod 23 is supported in a guide or barrel member 26 which is mounted on the side of the ladle 10.

The lower end 33 of the slide rod 23 may be provided with the usual mechanical linkage for manual operation of the stopper for use in the event of a failure of power for the power control device to be described.

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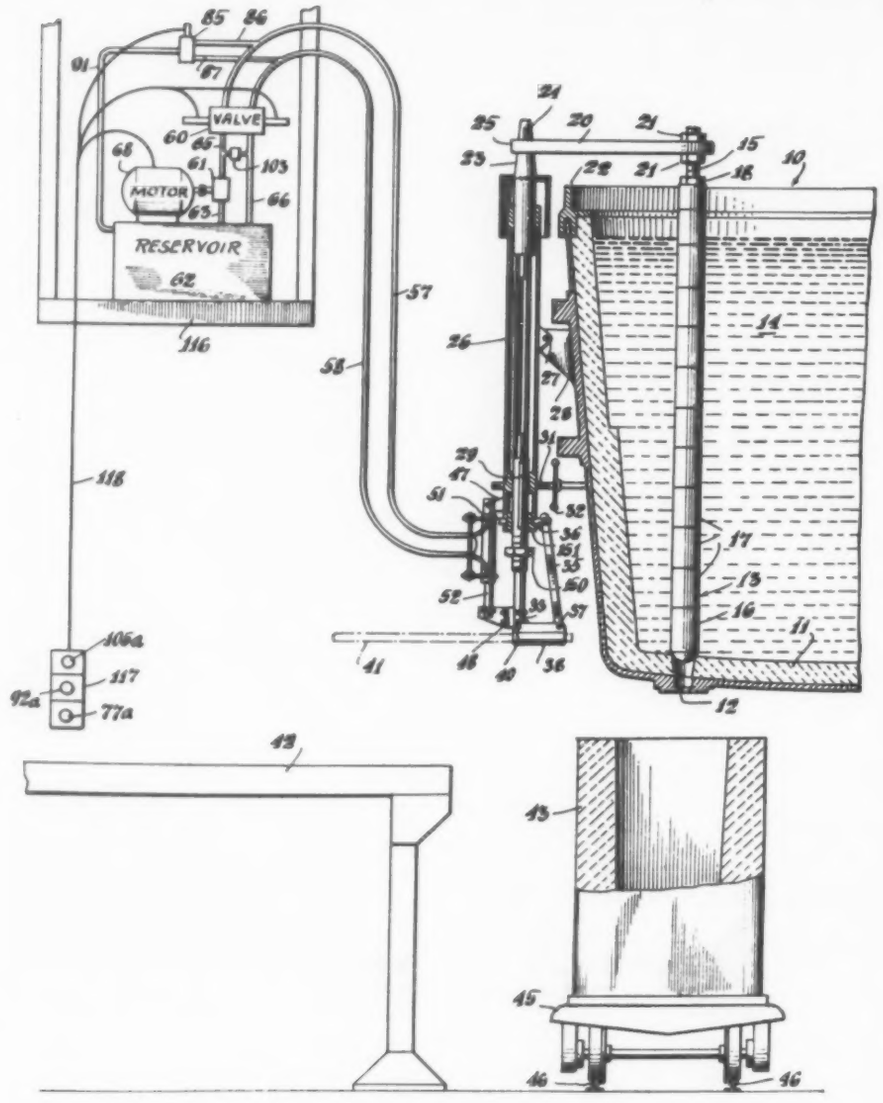

Figure 4

In this invention, it is contemplated to raise and lower the stopper by a double-acting hydraulic cylinder assembly 51 removably attached to standard stopper actuating apparatus. For this purpose, the upper end of the cylinder 51 is connected to a bracket 47 fixed on the slide barrel 26. Piston rod 52 is attached to a bracket 48 fixed on the lower part 33 of the slide rod 26 adjacent the pivot connection with the member 38. The cylinder is disposed so that a downward movement of the piston rod 52 causes a downward movement of the slide rod 23 and the stopper 13, and an upward movement of the piston rod 52 moves the slide rod 23 and the stopper 13 upward.

By means of the hydraulic system employing the substantially noncompressible fluid, the stopper can be moved to and maintained at any desired position within its normal operative range and can be rapidly and easily adjusted for the pouring of each successive ingot by means of the valve 60. To shift the stopper upward or downward, the operator need merely depress the corresponding one of the switch buttons 92a, 105a; so long as the selected button is depressed the piston and stopper will move in the corresponding direction, but will come to a halt promptly upon releasing the button, i.e., at the end of the desired change in amount of stopper opening. The neutral position of the valve 60 then permits the hydraulic cylinder to hold the stopper in the selected position. If a further or opposite change in stopper opening is desired, an appropriate switch button is again utilized in the same way. In all cases the operator can readily govern the length of time or the number of times he pushes the button by direct observation of the metal stream.

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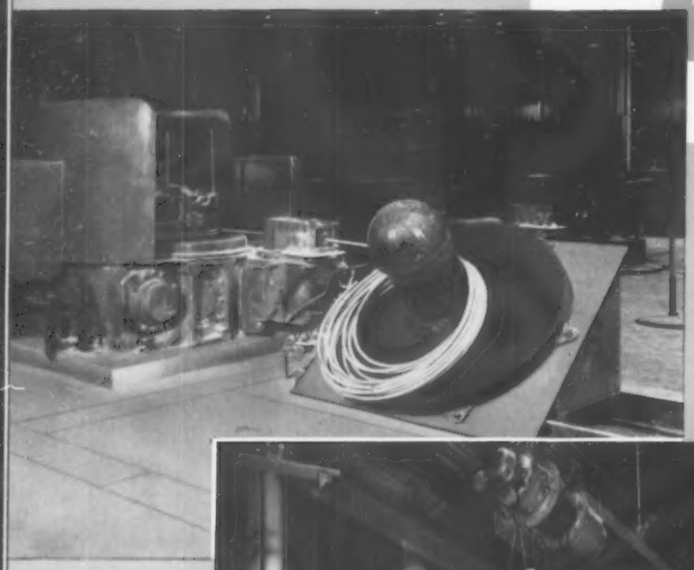

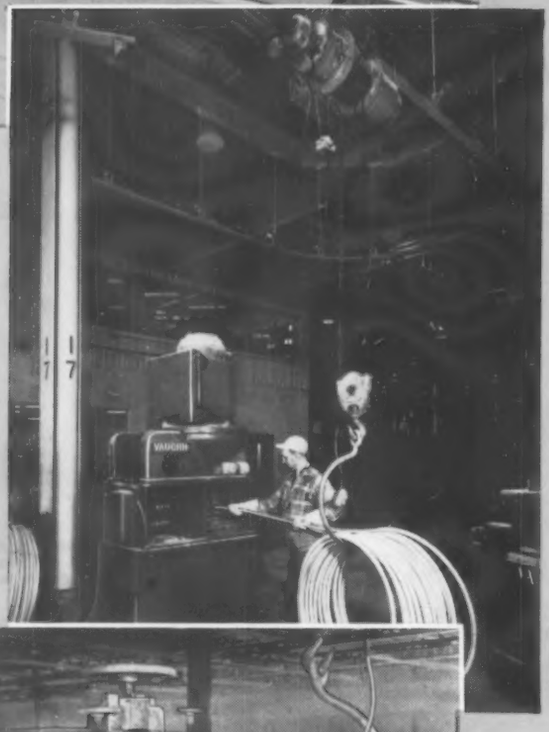

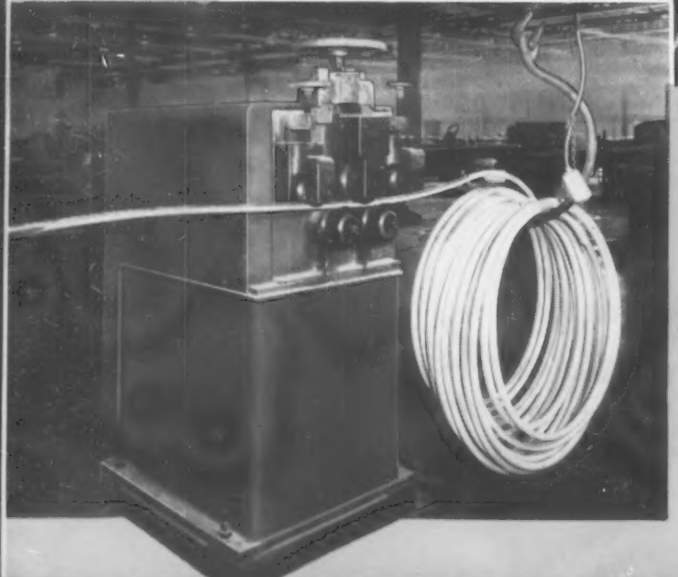

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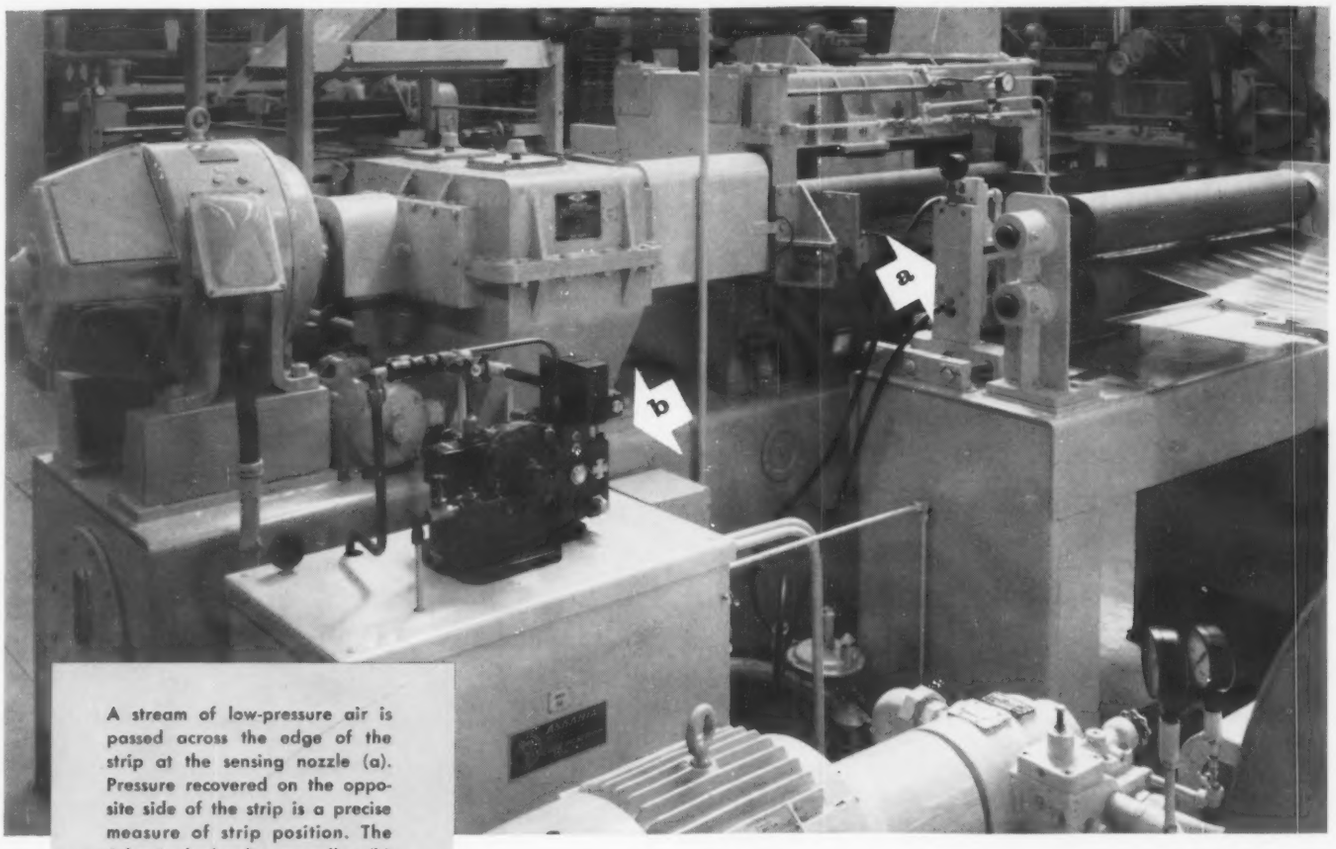
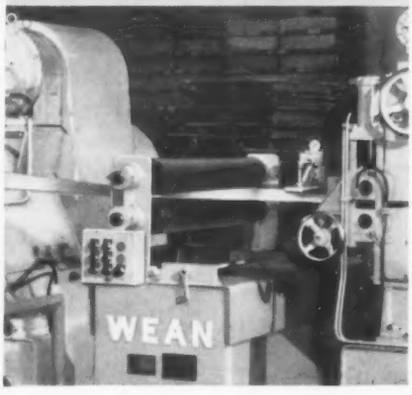


A stream of low-pressure air is passed across the edge of the strip at the sensing nozzle (a). Pressure recovered on the opposite side of the strip is a precise measure of strip position. The Askania hydraulic controller (b) translates any errors in strip position into movement of the work cylinder and pay-off reel. Lower photo shows push-button station where operator can over-ride the automatic control at any time.



This tin plate sheeting line, newly installed in American Can Company's Milwaukee plant by Wean Equipment Company, far outstrips the production of older equipment in the plant. It sheets tin plate for Milwaukee's beer cans at very high speeds. To keep the strip moving straight into the sheeter, no matter what the condition of the payoff roll, this operation relies on Askania Edge Position Control.

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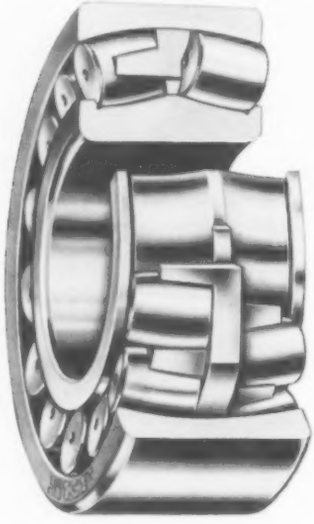

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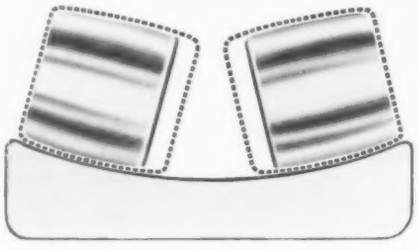
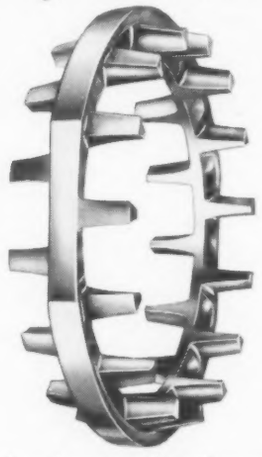


Fig. 1

2. OPERATE AT COMBINED HIGH ECCENTRICITY AND SPEED. This new bearing is equipped with a cage that withstands the stresses and wear caused by combined high operating speeds and by loads resulting from increased eccentric motion of the bearing.

So in this new bearing, SKF uses a cage made of centrifugally cast bronze having axially drilled and reamed pockets of a shape that conforms closely to the rollers' shape. Its spherical O.D. conforms to the contour of the outer ring sphere. It is symmetrical and made in one piece for dynamic stability. Thus, the cage is centered on large areas of contact located where effective lubrication is assured.



Centrifugally cast machined bronze cage

The new SKF Screen Bearings conform to 223 Series Spherical Roller Bearing dimensions. For details on the sizes available, call your nearest SKF sales office or authorized SKF distributor. Write for Bulletin 466—"Screen Bearings to Meet the Needs of Vibrating Screens."

7851

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

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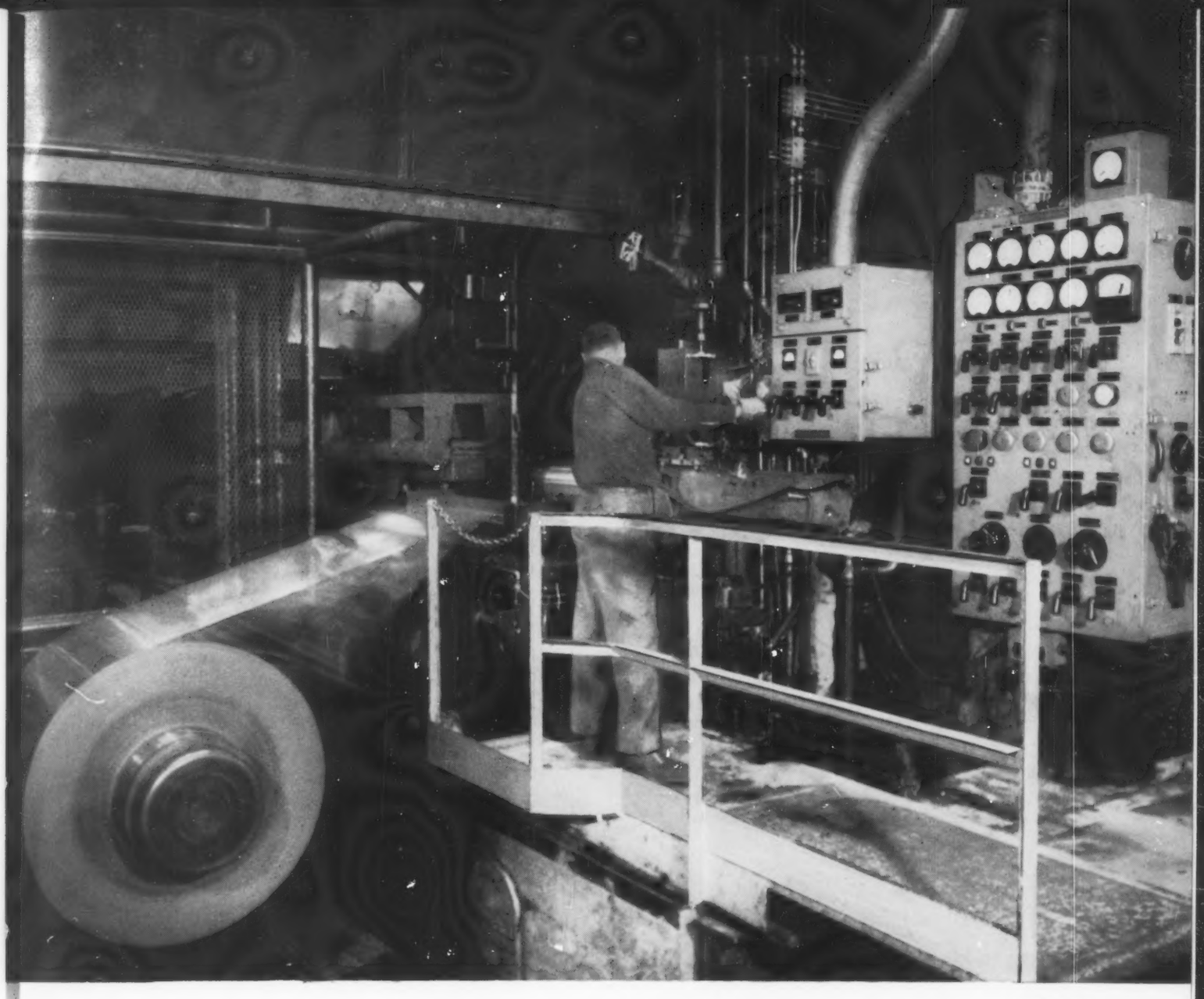


J-96121-1

AT 6000 FEET PER MINUTE...

Westinghouse Automatic Gauge Control on Wheeling Steel's New Tin Plate Mill Assures Plus/Minus .0001 Tolerances

In December, 1957, the new five-stand, 6000-fpm, tandem tin plate mill was officially put in service at Wheeling Steel Corporation's Yorkville, Ohio plant. The new 48″ mill has 22,500-hp total drive capacity to produce tin plate and heavier strip at speeds up to 6000 fpm.

Westinghouse equipment is used, entirely, to Power-Up this modern installation. One of the most outstanding new developments utilized is the Automatic Gauge Control, designed and furnished by Westinghouse—a practical necessity on a high-speed mill of this type.

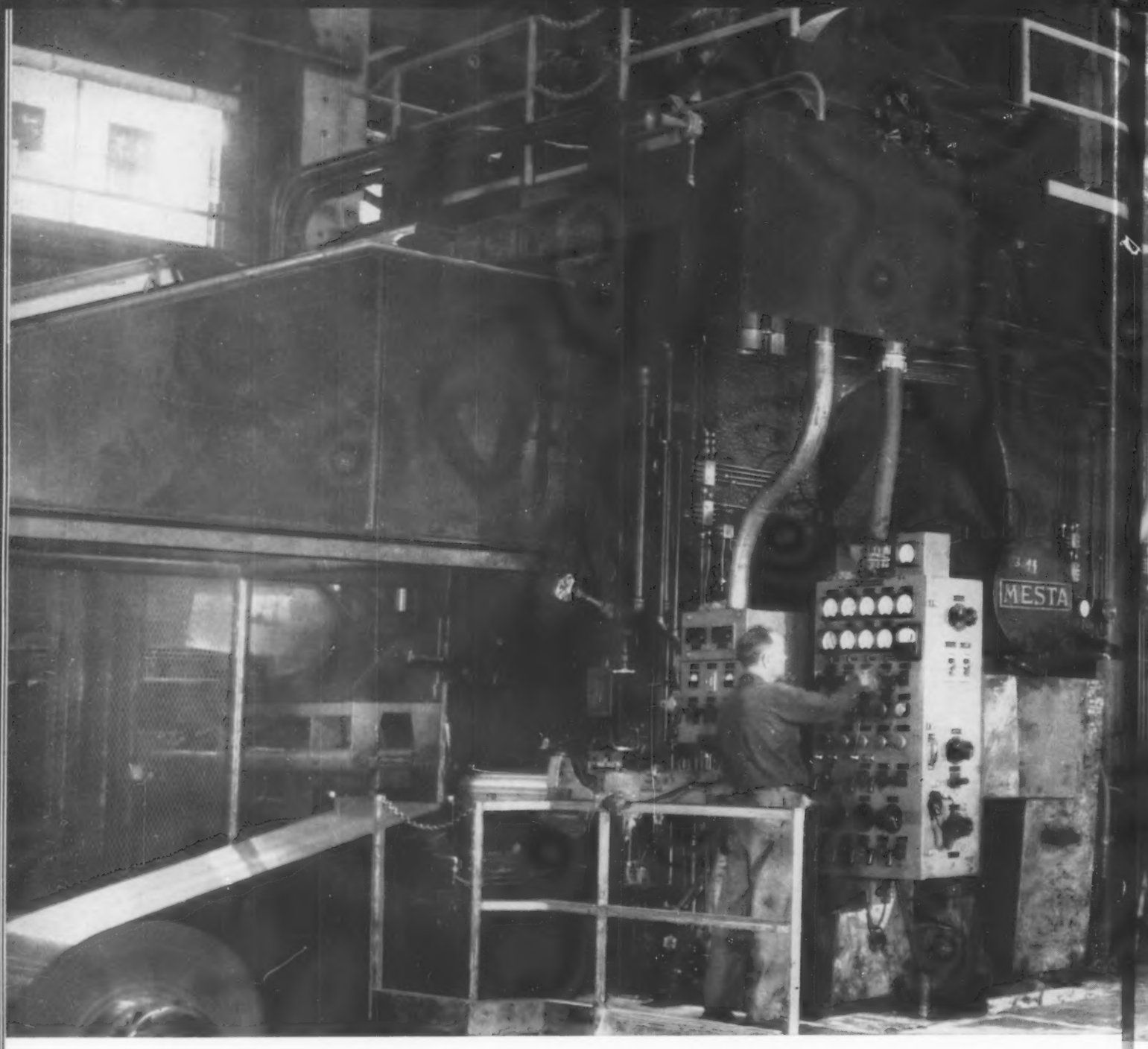
Other Westinghouse equipment furnished for this installation at Wheeling includes: main drive and all auxiliary motors, Magamp* regulators for main drive and variable voltage screwdown controls, M-G sets, brakes, outdoor substations, switchgear, power center, and control centers.

From planning to design, installation and start-up . . . Westinghouse can help you Power-Up. Consult your Westinghouse sales engineer for complete information. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*Trade-Mark

YOU CAN BE SURE...IF IT'S **Westinghouse**

Westinghouse Equipment Is Used Throughout the New Five-Stand Tandem Mill at Wheeling Steel Corporation's Yorkville Plant.



New Mill With Automatic Gauge Control Gives More Usable Strip From Every Coil--- Less Production Time Loss

With the automatic gauge control, strip thickness is continually gauged and recorded. Through feedback of signals, the mill automatically adjusts for any variation. Gauge control starts at #1 Stand, controlling the #1 Screwdown to minimize incoming variations. It thereby assures a uniform strip continuously to the mill.

The gauge control at #5 Stand controls the #5 Stand and the reel to adjust the strip tensions and maintain constant gauge of finished strip. The use of this new gauge control assures continuing close tolerance (to within plus/minus .0001) without production slowdown or unnecessary interruption.

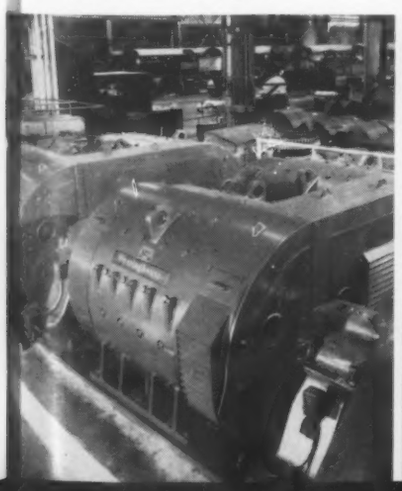
YOU CAN BE SURE...IF IT'S Westinghouse

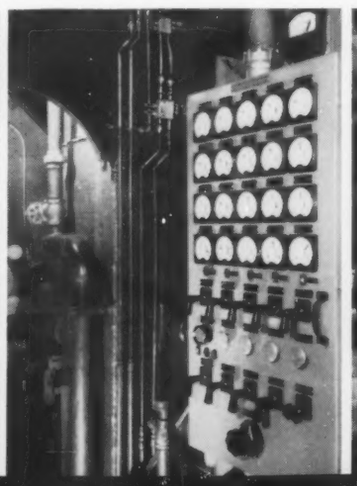
Two 3000-hp double armature motors for #5 Stand twin drive. Side-by-side mounting conserves floor space.

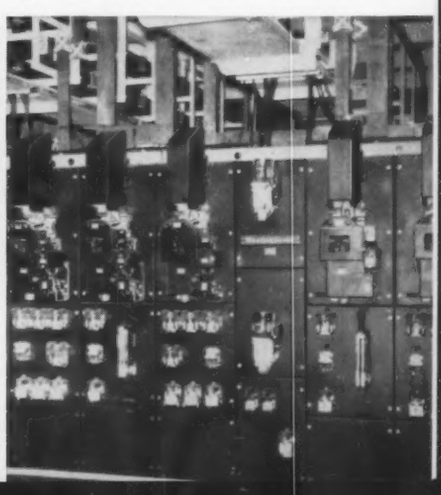
Tensiometer between stands shows strip tensions to guide operators in control of mill, and Westinghouse circular scale meters give maximum readability in minimum panel space.

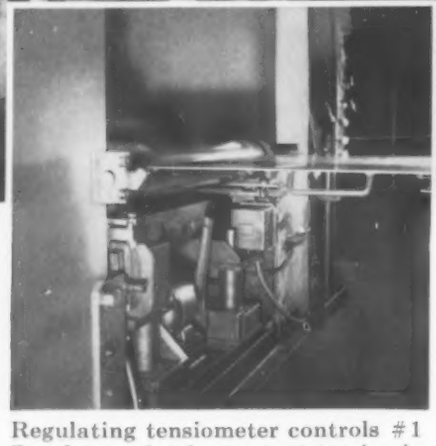
View of motor room showing main and screwdown M-G sets, switchgear and power center. Controls located on balcony at right.

#5 Stand motor and generator line control panels. All circuit breaker and dynamic braking panels are located in basement.









Regulating tensiometer controls #1 Stand to maintain constant tension in strip between stands 1 and 2.

Temper mill main drives. The entry and delivery tension roll twin drives feature special small-diameter machines to enable direct coupling to rolls on 20″ vertical centers.

Westinghouse-Powered Temper Mill at Wheeling Gives Higher Tonnage—Less Scrap

As part of their Power-Up program, the Wheeling Steel Corporation recently installed a new 48″ two-stand temper-pass mill, rated at 5000 fpm, equipped with 4600 total horsepower.

This Westinghouse equipped mill has increased the amount of strip produced as well as guaranteeing a better product because of the improved control possible.

Westinghouse equipment furnished includes: main drive and auxiliary motors, M-G set, switchgear, control centers and operating controls.

J-96121-4

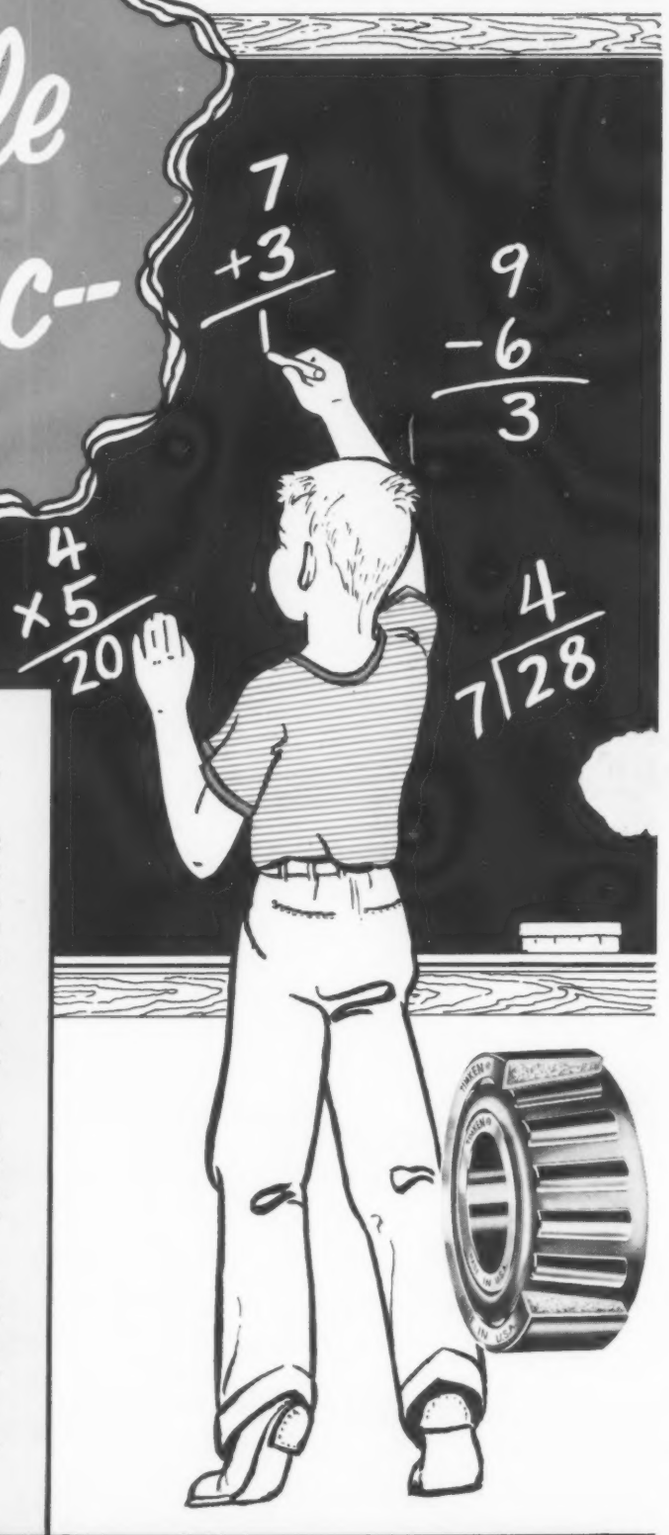
YOU CAN BE SURE...IF IT'S Westinghouse

For Coiling and Sheeting Applications

Stamco has equipment available in a wide range of sizes and speeds for coiling and sheeting applications in mill, warehouse or factory. These bulletins tell the complete story. Request them by number on your letterhead. No obligation.

STAMCO, Inc., New Bremen, Ohio

It's simple arithmetic--



HERE'S a highly practical suggestion--that will help you trim expense...and...cut ultimate cost.

Jot down on your memo pad the total invoice cost of the bearings you normally carry for replacement purposes. This figure represents capital *tied up* in inventory. Now, add the related costs for storage space, handling, insurance, taxes, and bookkeeping.

This simple arithmetic will not only reveal how much money you have invested in inventory...how much it costs you to maintain that inventory...but ...also what your bearings *actually* cost you.

Obviously, if you could reduce your investment, and your inventory costs--you'd trim your operating expense...and...your ultimate cost, proportionately. Like hundreds of other Berry customers, you can--quickly, and with no risk of work stoppage.

Berry Bearing Company has over 50,000 types and sizes of bearings, bearing specialties, and transmission appliances regularly in stock...and...can give you *anything* and *everything* you need--in approximately 27 minutes after you phone your order.

To reduce your inventory, trim expense, and cut ultimate cost--why not phone Berry now!

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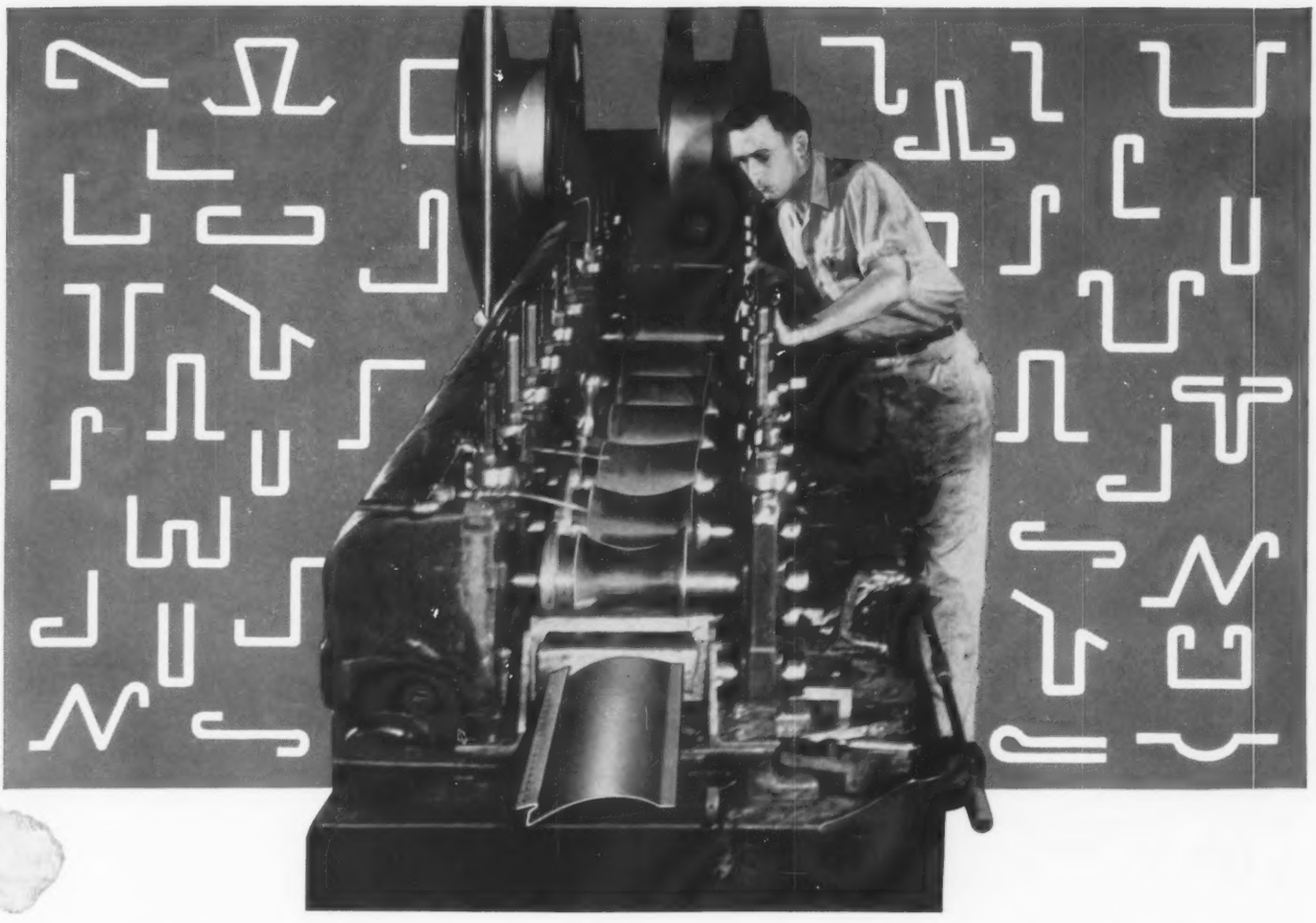

With a Yoder...ONE MAN PRODUCES 30,000 FEET OF SHAPES A DAY!

Cold-roll forming with a Yoder Roll-Forming machine makes spectacular production possible in many metalworking applications and industries.

A multitude of shapes, simple or complex, produced from a wide variety of coated or uncoated stock, and destined for a virtually endless list of purposes, can be easily, quickly and economically produced with a Yoder cold-roll forming machine.

Whether it be moldings, structurals, siding, roofing, tubulars, cabinet shells, or any one of a thousand requirements, it can be quickly produced with accuracy and uniformity the Yoder way. The conversion cost is usually so low that even part-time operation makes a Yoder cold-roll forming line a profitable investment.

A great many modifications of the basic shape such as welding, coiling, ring forming, notching, perforating, embossing and cutting to length, can be simultaneously introduced with little or no additional labor cost. It will pay you big dividends to fully investigate the advantages of Yoder cold-roll forming. A fully-illustrated, 88-page book clearly discusses every important aspect of this amazingly versatile method of metal fabrication... it is yours for the asking.

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COLD ROLL FORMING MACHINES
PIPE AND TUBE MILLS (ferrous or non-ferrous)
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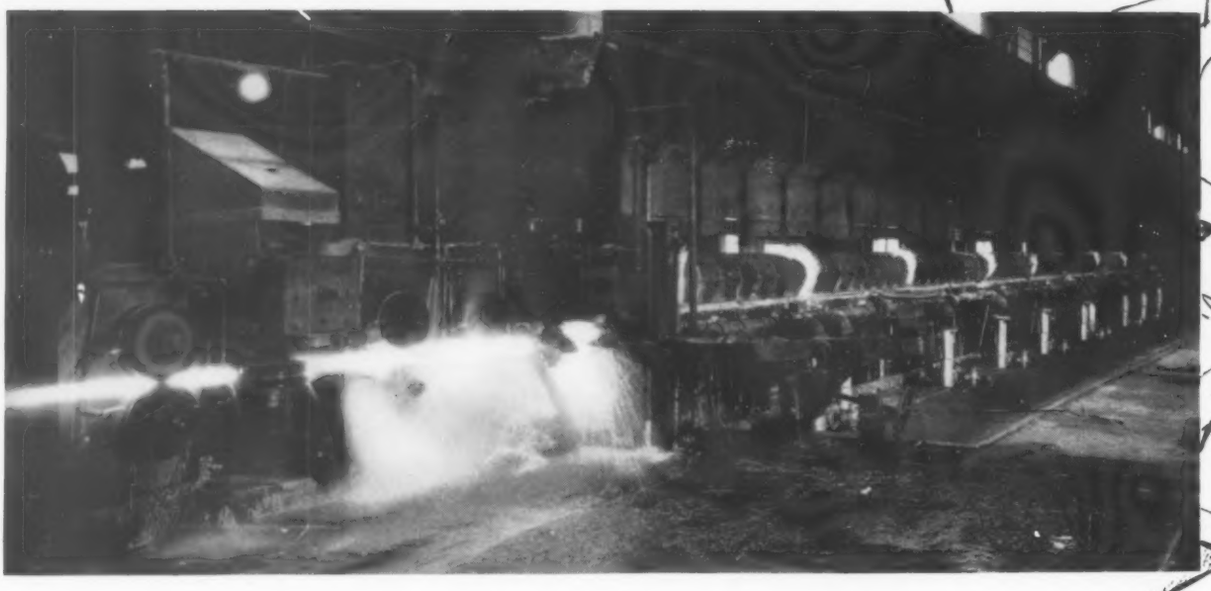
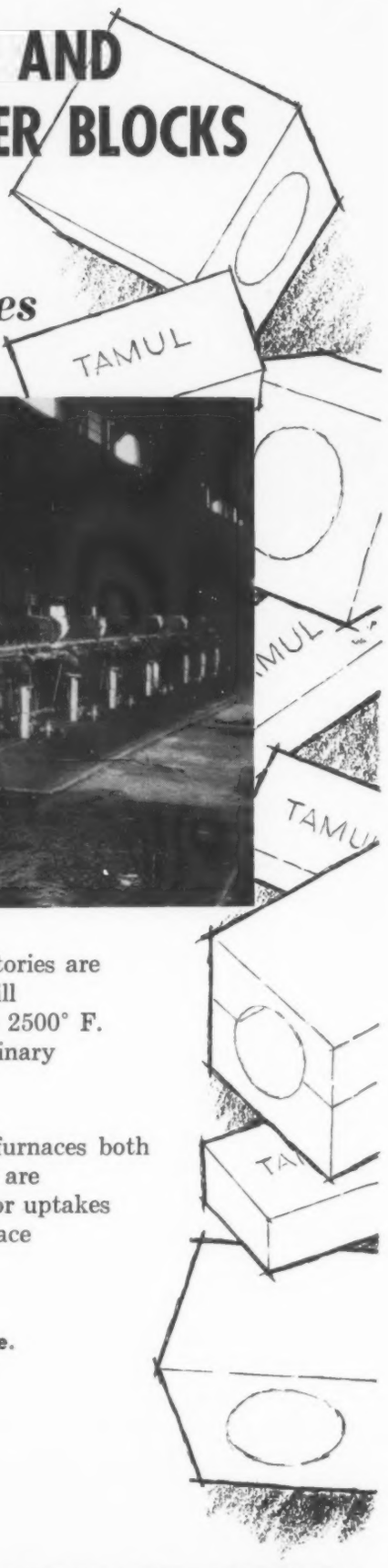
TAMUL BRICK AND BURNER BLOCKS

speed production in continuous pipe mill furnaces





TAMUL® (Taylor sintered synthetic mullite) refractories are preferred by operators of continuous butt-weld pipe mill furnaces*. Heating cold skelp for ½" diameter pipe to 2500° F. in 21 seconds produces furnace conditions in which ordinary refractories quickly fail.

TAMUL burner blocks are regularly used in these furnaces both on original installations and on repairs. TAMUL brick are installed in the inner linings of side walls, in recuperator uptakes and in the bungs. This condition results in longer furnace campaigns because TAMUL has:

- **High softening point.**
- **Freedom from shrinkage in service.**
- **High hot load strength.**
- **Good resistance to slagging.**

** Engineered and built by Salem-Brosius, Inc., Pittsburgh, Pa.*

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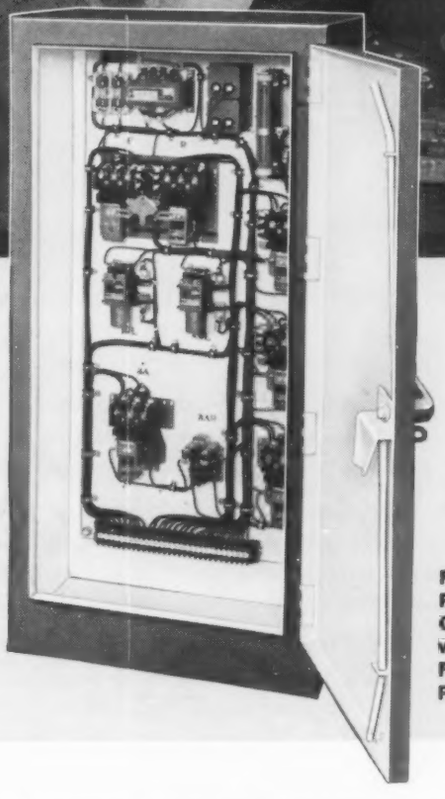
EC&M

"VL" AC CRANE CONTROL

for light
industrial* crane service



Form VLRP Reversing Controller with Frequency Plugging Relay

• Designed specifically for light industrial AC cranes, EC&M's full magnetic "VL" control assures smoother, more efficient operation than manual control. On cab-operated cranes, operators have greater freedom of movement with small masters mounted up-front and controllers at rear of cab. "VL" control is also available for cranes operated from floor by pendant push-button master.

EC&M "VL" Controllers are compact and have vertical-action type contactors. The well-known EC&M Frequency Relay provides accurate control of accelerating operations on Dynamic Lowering hoists. Timed acceleration is provided for Reversing hoist, Bridge or Trolley controllers. "VL" controllers have "individual protection," eliminating the need for separate protective panel. They are front-connected and wired for easy inspection and maintenance.

A companion line to EC&M's "PT" Control for DC cranes, this new "VL" control is far superior to manual control previously specified purely on the basis of price.

**NEMA Service Classification II applications*

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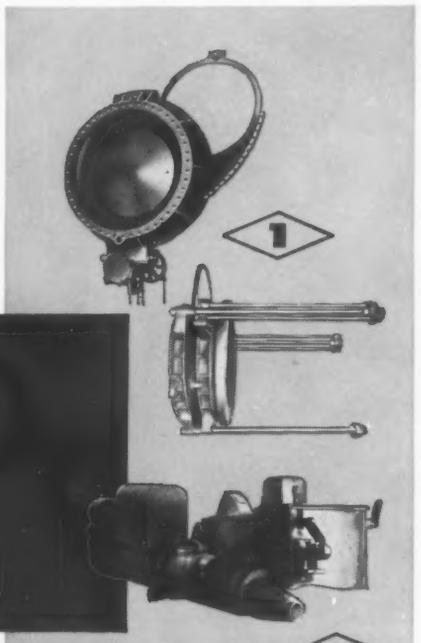

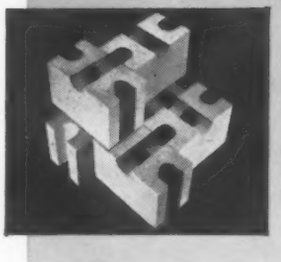

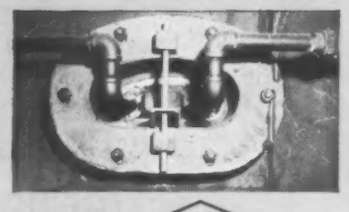

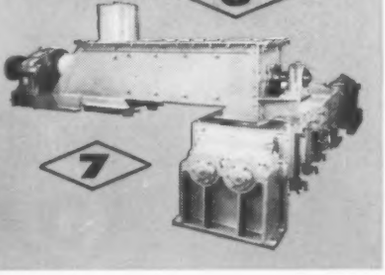

1 For Controlling Gas Mains... Bailey Goggle Valves in thermal expansion (36" to 120" diameters) and mechanical (6" to 72" diameters) types.

2 For Plugging Tapping Holes... Bailey Clay Guns provide plenty of power and clay capacity for maintaining long holes.

3 For Blast Furnace Stoves... Bailey services include design, construction and relining — using Kennedy Checkers with cross-flue feature.

4 For Cooling Blast Furnace Linings... Bailey Cooling Plate Holder provides a gas- and water-tight seal, with ease of removal for inspection or replacement.

5 For Pig Casting... Bailey Pig Casting Machines provide trouble-free service while increasing casting capacity for foundries and blast furnaces.

6 For Stopping Cinder Notches... Bailey Cinder Notch Stoppers eliminate hazards to workmen at the cinder notch.

7 For Sintering... Bailey Pug Mills assure efficient pugging or mixing for blast furnace dust catchers and sintering plants. Feeder illustrated for Dust Catcher Mill maintains an even flow of the material to be processed.

Other Bailey Products: Blast Furnace Cold Blast Valve • Blast Furnace Blow-Off Valve • Check and Snort Valve • Mixing and Check Relief Valve • Fabricated Steel Stove Bottom • Precision Table Feeder • Ladle Skulling Hook

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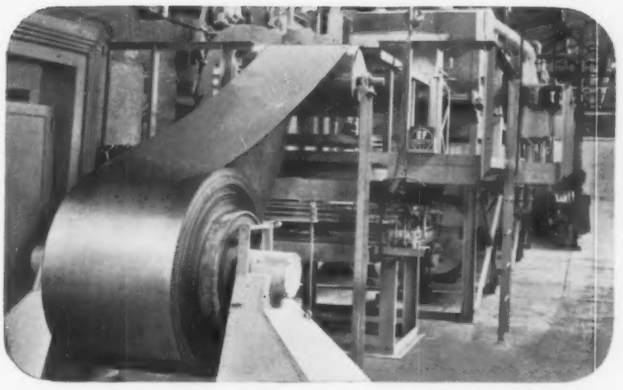
SPECIAL ATMOSPHERE TREATMENTS AND OTHER PROCESSING



EF continuous strip line—for annealing, galvanizing, aluminizing, and pruducing various surface and metallurgical conditions on ferrous and non - ferrous strip.

EF gas fired continuous roller hearth special atmosphere furnace bright annealing long straight lengths of tubing.

EF PRODUCTION FURNACES
for these and other processes

• Reflecting more than 40 years of continuous research, experience and outstanding engineering accomplishments, EF production furnaces combine high heating efficiency—accurate, automatically controlled cycles—high fuel economy—and produce products with uniform physicals and surface finish year after year.

For advanced engineering designs that minimize maintenance and produce high hourly outputs, turn your production furnace problems over to experienced EF furnace engineers—IT PAYS.

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Part of an installation of large EF gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing steel strip.

If you use cutting

Big News

How Engineered Oxygen Cutting Can Increase Your Profits

A new concept in cutting machine techniques may revolutionize your thinking on what can be accomplished by oxygen cutting equipment. Messer cutting machines feature a distinctive design and construction.

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Through a completely engineered system of operation, you can now achieve new standards of accuracy in precision workmanship! This means improved production efficiency in many industries where metal-working is involved. Messer machines can SAVE YOU MANY DOLLARS.

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Relatively new in the U.S.A., Messer is the acknowledged leader in cutting machine

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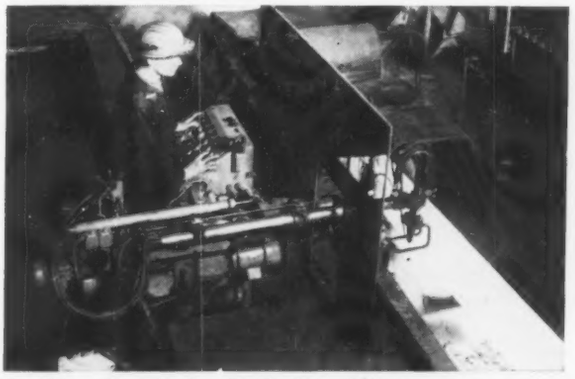
machines, here's

For YOU!

design throughout Europe and in other countries. Now in America, Messer cutting machine versatility of design permits greater shop flexibility and the increased use of automation that leads to **greater profits.**

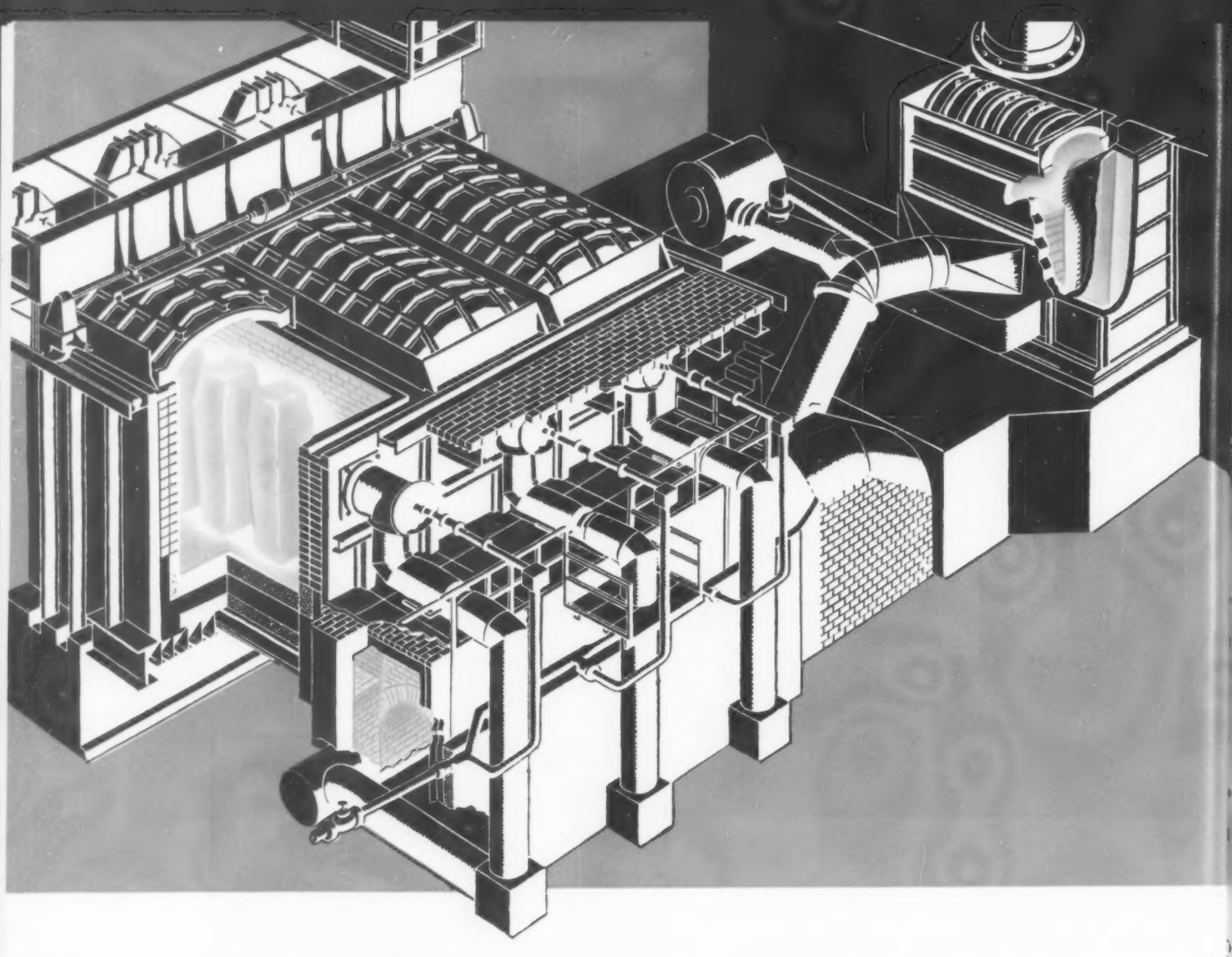
If you use—or could use—oxygen cutting machines—it will pay you to check *now* on what Messer can offer you. Write for full information. No obligation, of course. **MESSER CUTTING MACHINES, INC., Chrysler Building, 405 Lexington Avenue, New York 17, N. Y.** *Precision Cutting Machines—Oxygen, Nitrogen, Argon Plants.*

Unlimited plate area or complex cutting operations present no problems to Messer equipment.

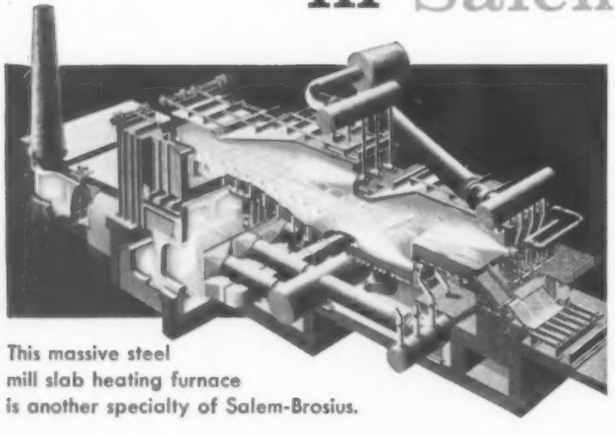


Complete automation is a key feature of Messer cutting machines, as used in this steel mill.

Machines



Ingot heating is fast and uniform in Salem-Brosius soaking pits



This massive steel mill slab heating furnace is another specialty of Salem-Brosius.

This battery of Salem-Brosius rectangular soaking pits currently is in round-the-clock operation heating ingots in a large steel mill. Of this installation, a top operating official said: "These pits are heating more steel ingots ready for rolling with less fuel consumption, less maintenance costs, and better temperature uniformity than any other type of pit in our plant."

Reports like this are typical, not only about these rectangular soaking pits, but all Salem-Brosius furnaces. Salem-Brosius engineers possess an enviable record for designing furnaces that produce maximum, high-quality output at minimum operating cost. If your plans call for soaking pits or any heating or heat-treating furnaces, send us an inquiry. There will be no obligation.

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SPECIAL MECHANICAL EQUIPMENT • INDUSTRIAL HEATING FURNACES • MATERIALS HANDLING EQUIPMENT

VIEWING FURNACE DROP-OUTS AT JONES & LAUGHLIN'S 44″ HOT STRIP MILL

"Our RCA TV makes furnace charging more efficient–easily paid for itself the first month!"

—says Bob Grimm of J. & L.

RCA Television Camera in weatherproof housing looks into reheat furnace.

The furnace charger on the 44″ mill at Jones & Laughlin's Aliquippa Works, watches his charge of cold slabs enter the furnaces outside of his pulpit and then, on his TV screen, "sees" the heated red-hot 18,000-lb. slabs drop out on the rolling mill approach table 100 feet away! By actually *seeing* the slabs he can avoid pushing more than one slab at a time. He can also keep slabs from getting caught and cooling down on the skids which lead out of each furnace, thus preventing camber and loss of production.

Before using television, the furnace charger simply had his signal lights to depend on. Since the ITV installation, the mill has made new records in rolling. In one hour it has been able to roll as many as 63, 6″ thick slabs, up to 282″ long. "Our RCA closed circuit television more than paid for itself in its first month of use here," says Robert Grimm, Assistant General Foreman. "We have a much more efficient operation as a result, with fewer delays and improved production."

Wherever used, whether for remote observation of mills, shears, furnaces, fuel burners, instruments or gates, RCA closed circuit television is proving its value by increasing efficiency and reducing costs.

RCA Industrial TV is designed and produced to exacting standards by the world leader in electronics.

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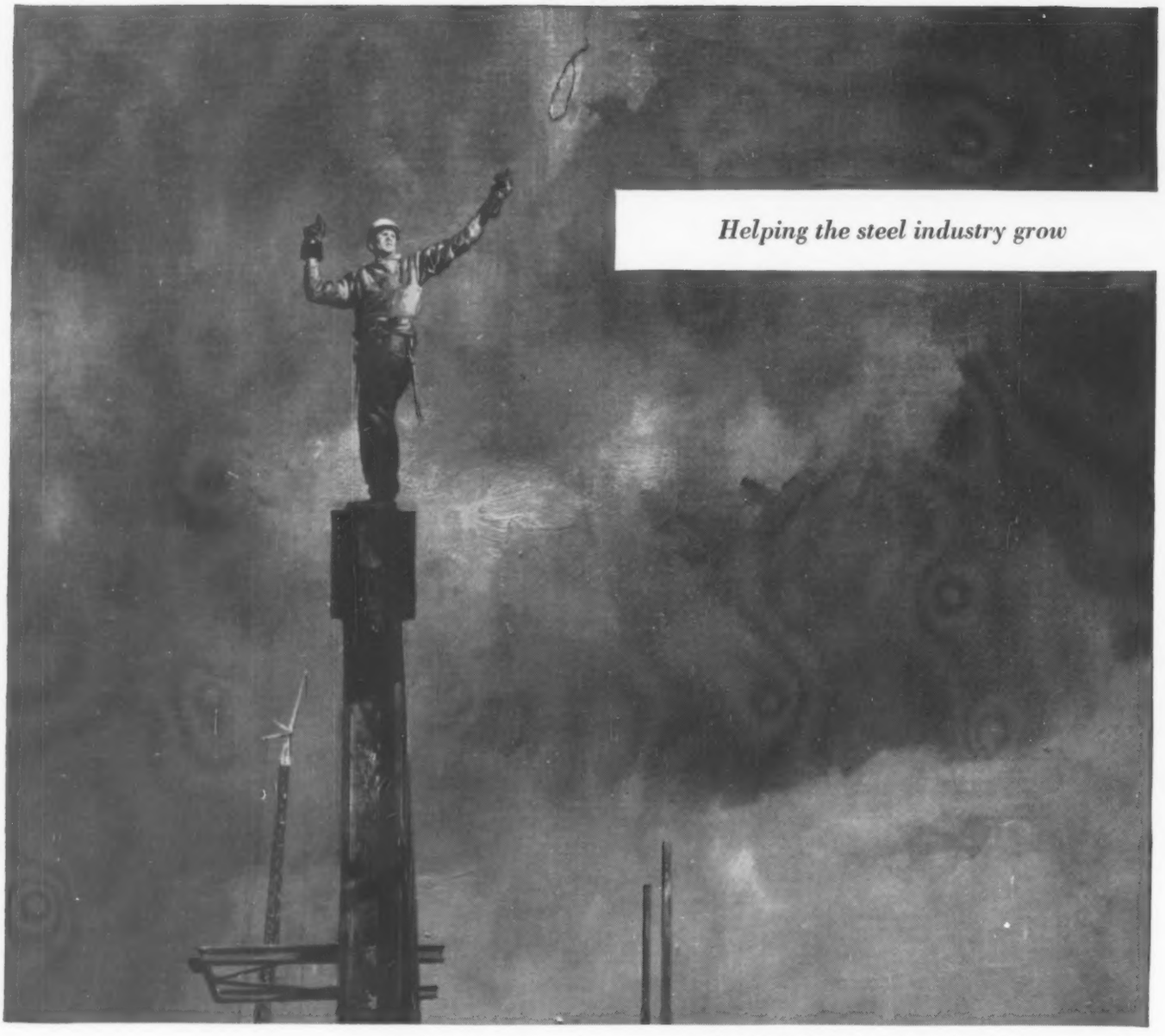

Steel soars skyward as girders are spudded and bolted into place by catfooted high-steel workers. Crack engineering teams, men whose life is construction, an endless river of steel—together they answer the call of our growing industrial economy. Composed by Stanley Meltzoff.

Control Costs in Construction

Regardless of the size and complexity of a project, cost control is invariably an important factor in its design and construction. Our experienced teams have proved over and over their ability to complete projects on schedule and within established budget limits. We offer a broad, flexible range of services—and facilities for moderate or extensive needs.

We have served many of the country's leading steel producers, designing and installing such facilities as rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, and coal handling equipment.

Let the skills and creative abilities of United Engineers augment the engineering staff of your own organization. We invite you to share and profit from our background of more than 70 years' experience.

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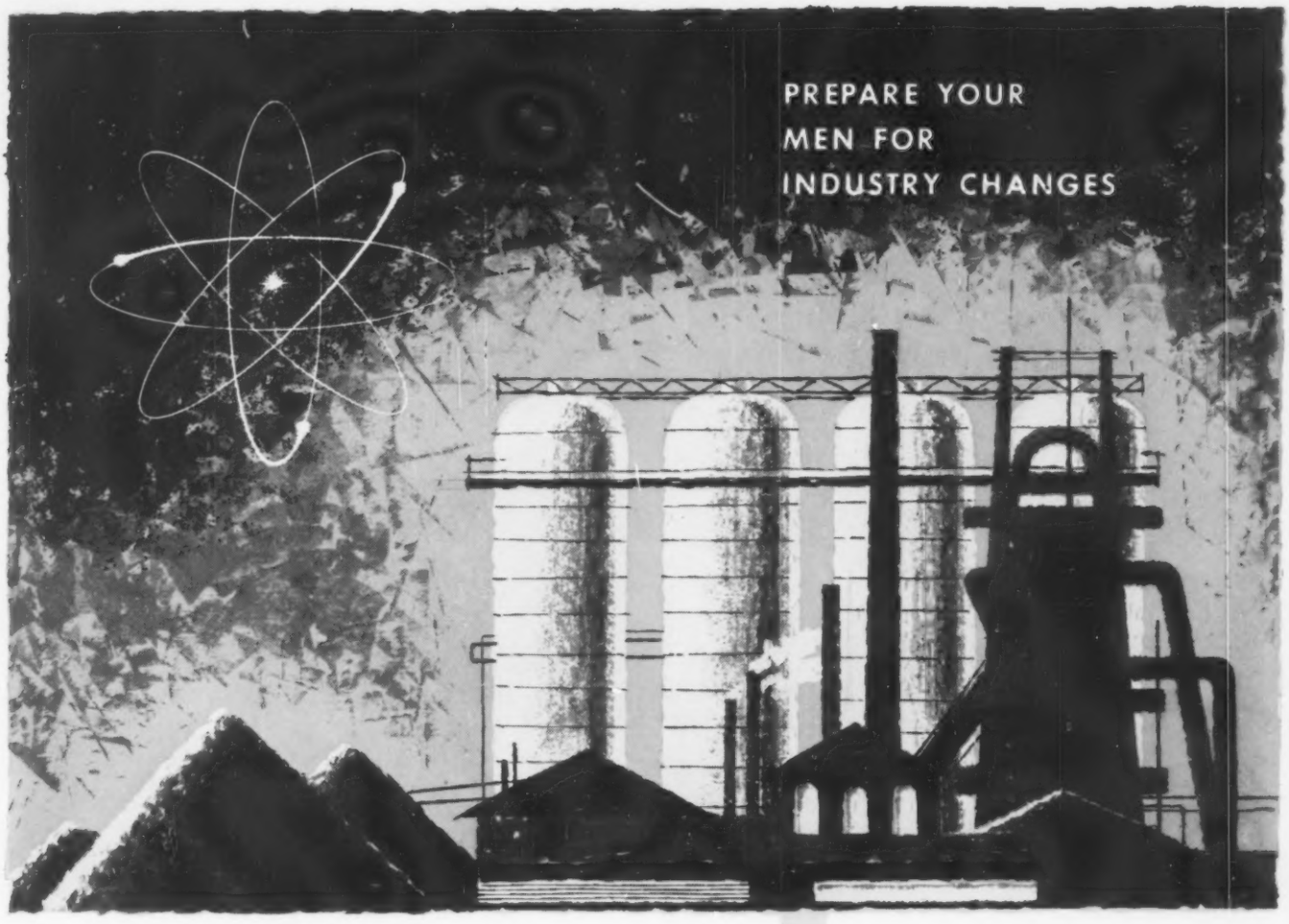

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Steel Mill Techniques being advanced

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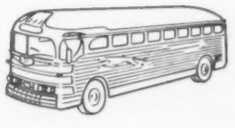
CLEVELAND AUDITORIUM
SEPT. 23-26

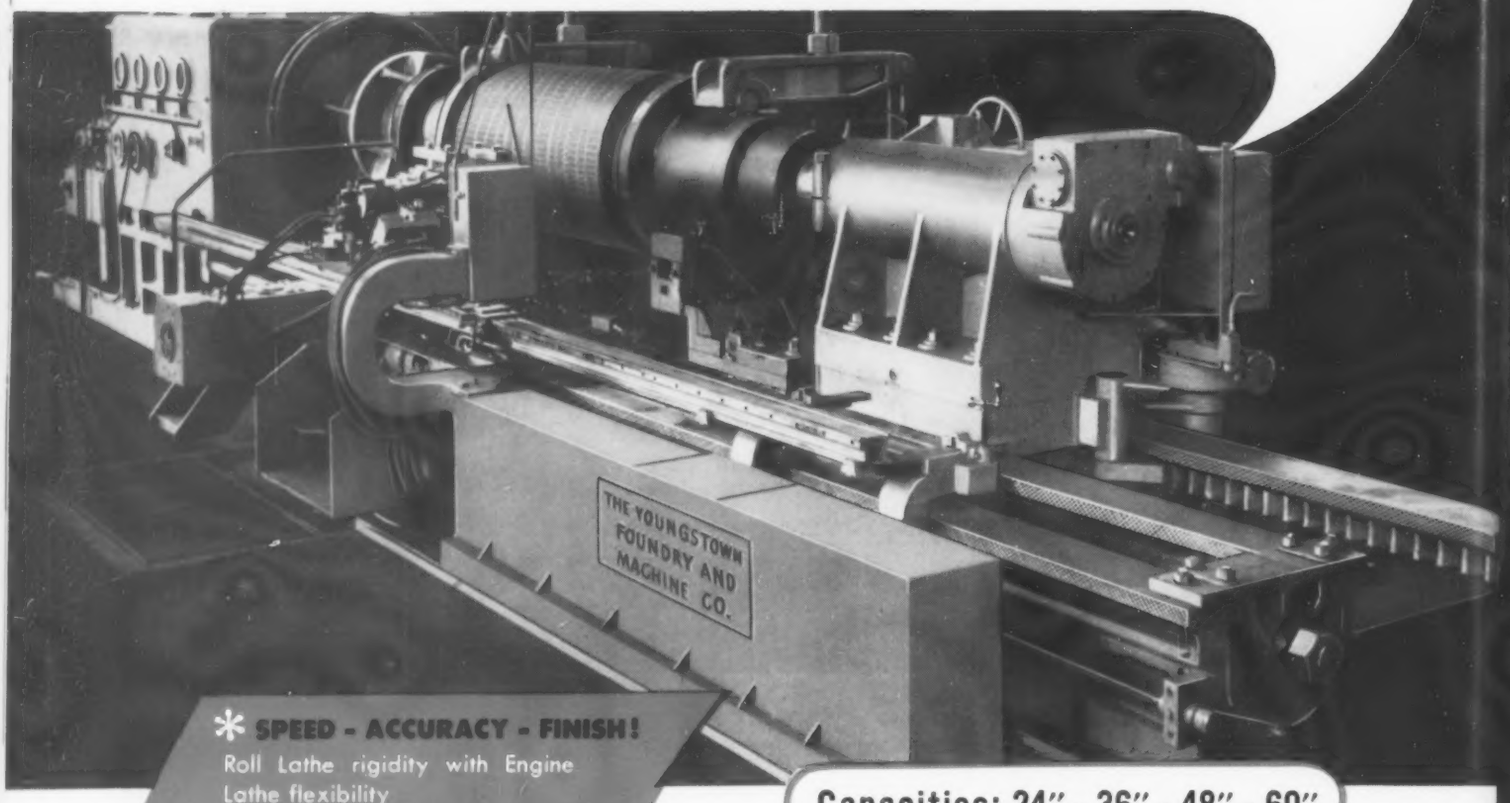
COVER BOTH IN ONE TRIP!

Special Greyhound Charters available—your plant to show and return.



tomorrow's design in today's

Now "YOUNGSTOWN" Contour Roll Lathes*



Capacities: 24" - 36" - 48" - 60"

*** SPEED - ACCURACY - FINISH!**
Roll Lathe rigidity with Engine Lathe flexibility

*** NEW HYDRAULIC TRACER**
controlled automatically. Front mounted tracer and templet for operating ease and faster set-up

*** NO FACEPLATE OVERHANG!**
Faceplate supported by extra large Timken roller bearings mounted on extra large torque hub to carry heavy radial and thrust loads

*** NEW TOOL POST & CARRIAGE**
designed for either single point carbide-tipped tools or regular roll turning tools

*** RUGGED HEAD STOCK!**
Herringbone gearing; automatic lubrication; illuminated inspection ports

Turn rolls better and faster with Automatic Tracer Control

Far ahead in design and efficiency, this new roll lathe has been developed to turn rolls better and faster . . . either on necks or centers . . . from the smallest bar mill roll to the largest back-up roll. Tested and proved in our own roll shop. Capacities to meet your specific needs.

The 48" roll lathe pictured has a speed range of 1.40 RPM to 81.1 RPM. Roll capacities: 18" minimum diameter, 50" maximum diameter, with 20'0" maximum length. Hydraulic ragging attachment can be furnished, as illustrated. Tell us your requirements . . .

Write for Complete Information

The Youngstown Foundry & Machine Company

Serving Industry Since 1885

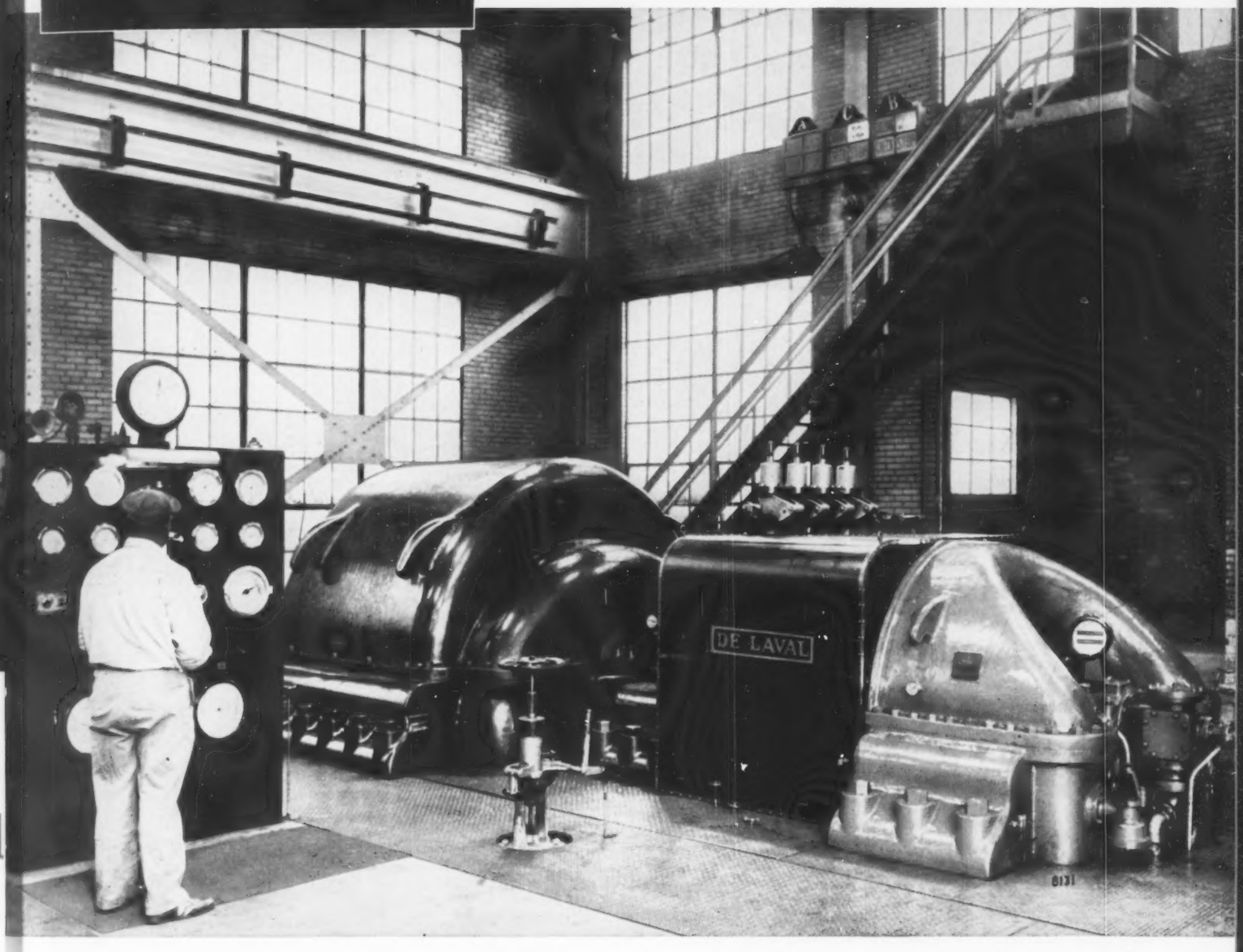
Youngstown 1, Ohio

HEAVY MACHINERY • AUXILIARY EQUIPMENT • CASTINGS • ROLLS

"YF&M" builds the best of them

DE LAVAL
BLAST FURNACE BLOWERS

give 20 years of service at Great Lakes Steel Corp.



Shown is one of two De Laval centrifugal blast furnace blowers at the Ecorse, Michigan, plant of the Great Lakes Steel Corporation, Division of National Steel Corporation. This 85,000 cfm unit was installed twenty years ago; another 75,000 cfm unit went on the line a year earlier. Both have given dependable round-the-clock service ever since. These turbine-driven blowers are hooked up to a multi-head which enables either one to be used in conjunction with any of the three blast furnaces.

De Laval centrifugal blowers are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem.

Send for Bulletin 0504

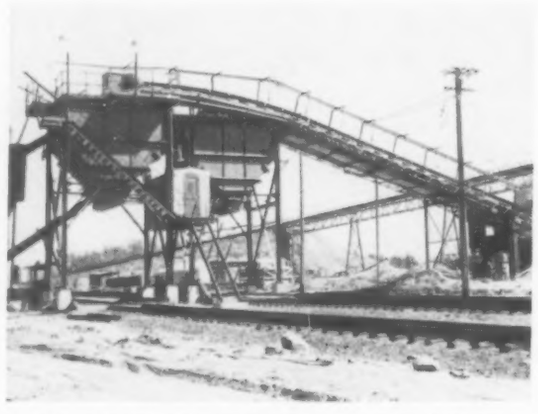
DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL-381

A complex material handling project is a job for...

CREATIVE ENGINEERING



Railroad loading bins for iron ore. Raw ore belt from pit is 2290 feet horizontal distance between centers and rises 256 feet in one flight.

Tell us what materials you want to move—how far—in what tonnages. However complex your problems may be, Roberts & Schaefer will engineer a system that will deliver the performance, flexibility and economy your project must have. Every material handling project is unique. Each presents problems. The capacity for original thinking and sound engineering and construction is one reason why so many R&S projects are for old customers who got what they wanted the first time.

Your Roberts & Schaefer material handling plant, designed to your specifications with complete processing, distributing and storage facilities, will be built to give you the maximum return on your investment.

ENGINEERS & CONTRACTORS

ROBERTS & SCHAEFER Company

130 NORTH WELLS STREET, CHICAGO 6, ILLINOIS

NEW YORK 19, N.Y. • PITTSBURGH 22, PA. • HUNTINGTON 10, W. VA. • ST. PAUL 1, MINN.

HERE'S SELF-ALIGNMENT

in a steel housing

"MILL BEARINGS" have super-rugged cast steel housings. Caps are anchored by extra-large dowels and four heat-treated thru-bolts with serrated steel nuts. "Mill-Bearings" are effectively sealed, self-contained, factory adjusted —need no shims or alignment rings at installation.

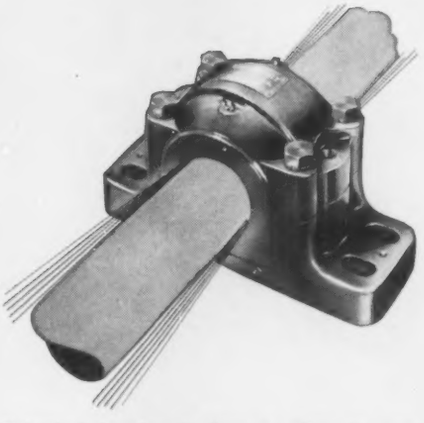
LINK-BELT "Mill Bearings" compensate for shaft deflections in extra-severe applications

With cast steel housings plus *self-alignment*, Link-Belt "Mill Bearings" are a perfect match for the grind and grime of heavy loads in steel mills, mines, foundries and similar grueling service. They instantly adjust to shaft misalignment . . . accommodate minor inaccuracies of welded and concrete support structures . . . end need for extra-heavy shafting to avoid deflections which ruin ordinary bearings.

Link-Belt "Mill Bearings" are part of industry's most complete line of self-aligning ball and roller bearing blocks. You can get full information from any of 40 Link-Belt offices or your authorized stock-carrying distributor.

LINK-BELT

MANUFACTURERS OF SELF-ALIGNING BALL AND ROLLER BEARINGS



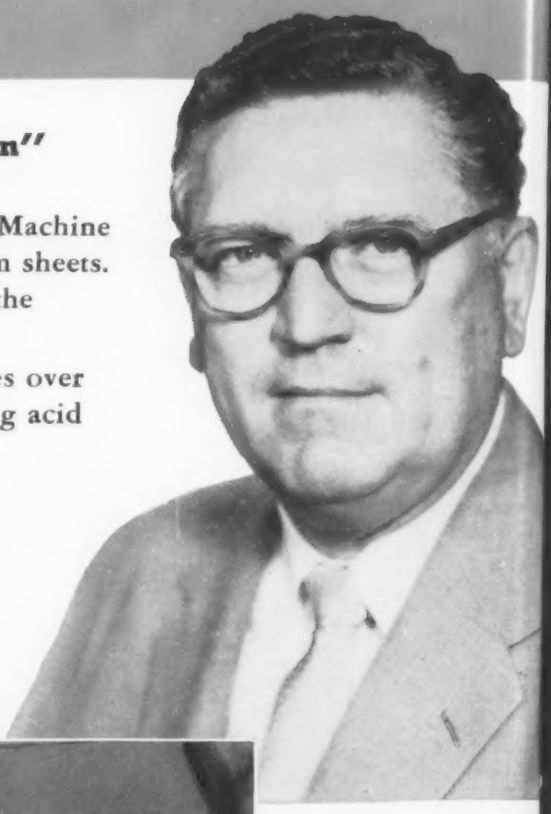
Spherical bearing is free to align in any direction, assuring full load capacity regardless of shaft deflection.

See our exhibit—Iron and Steel Exposition Cleveland, Sept. 23–26—Spaces 122–125

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,906

"...an all-round solution to the problem of removing scale from sheets"

says T. A. SULLIVAN, Plant Manager,
Granite City, Ill. Works, A. O. Smith Corporation

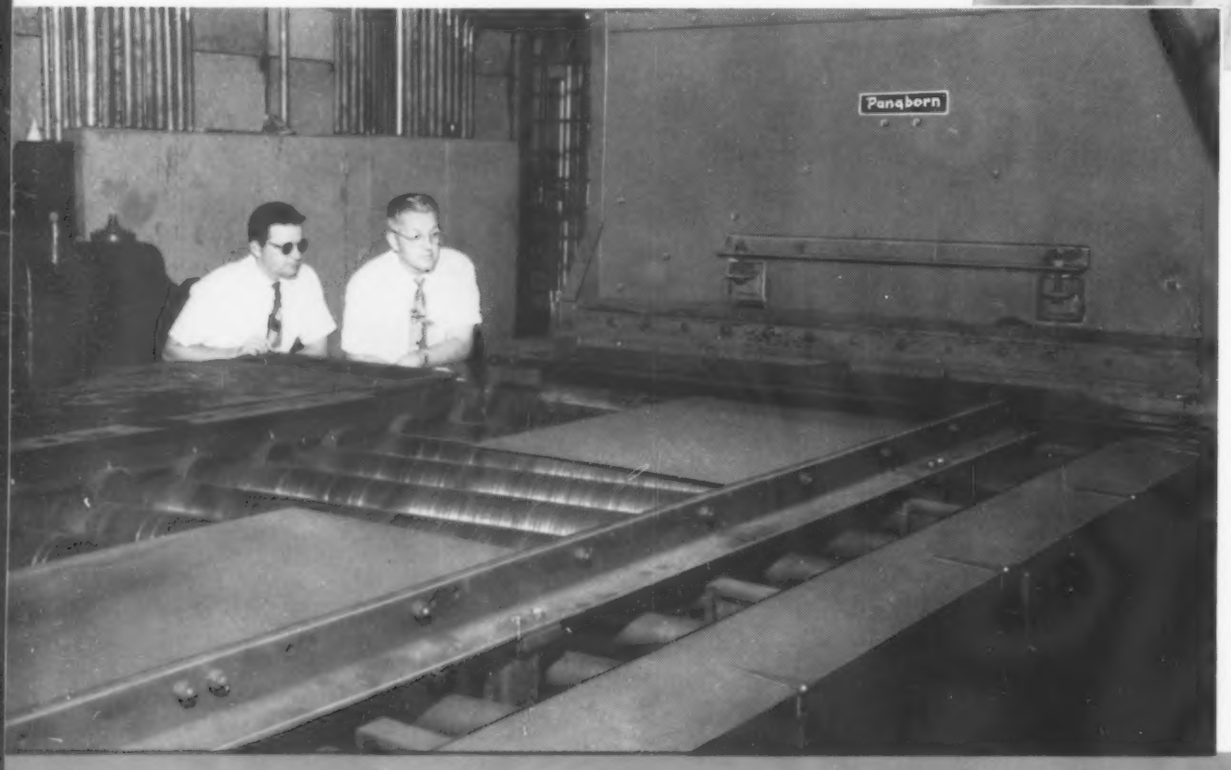


"Extremely pleased with high volume of production" of PANGBORN DESCALING MACHINE

"In many ways," says Mr. Sullivan, "the Pangborn Descaling Machine is an all-round solution to the problem of removing scale from sheets. We're extremely pleased with the high volume of production the machine is handling . . . it's fast and thorough."

And A. O. Smith management rates the following advantages over pickling equally important: conserving floor space—eliminating acid disposal problems and hazards to employees—better working conditions and plant housekeeping—more fully automated plant that saves time and labor.

If you're descaling sheets, plates, coils and rods, write today for Bulletin 608, PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning & Dust Control Equipment.*



At A. O. Smith, sheets descaled on this Pangborn Descaling Machine draw easily, weld readily . . . and the fine matte surface takes a permanent bond.

Pangborn ROTOBLAST® cleans cheaper

IRON & STEEL EXPOSITION • SEPTEMBER 23 - 26 • BOOTHS 321 - 328 • CLEVELAND, OHIO

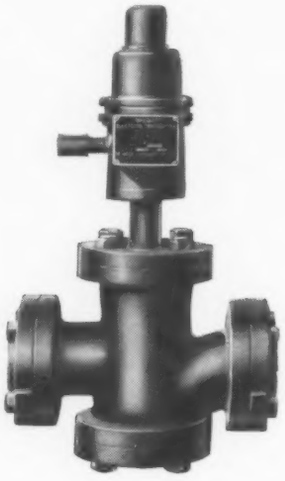
You're Welcome!

THE McDOWELL FAMILY OF RELATED ENTERPRISES

McDowell Turnkey Plants • Dwight-Lloyd Research Laboratories • Wellman Bulk Materials Handling Systems and Steelmaking Machinery • Anker-Holth Power Cylinders • Dwight-Lloyd Ore Beneficiating Plants • ABCs Belt Conveyor Scales • Williams Buckets • Wellman Locomotive Cranes • Wellman-Galusha Gas Producers

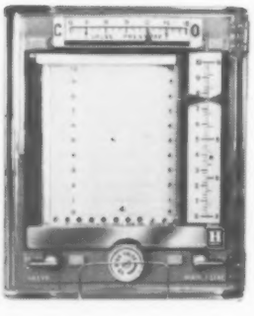
HONEYWELL INSTRUMENTATION FOR
FUEL-AIR RATIO CONTROL SYSTEMS

***ELECTRONIK* FLOW METER** can combine flow recording, indicating, electronic integration, pneumatic or electric transmission and control.



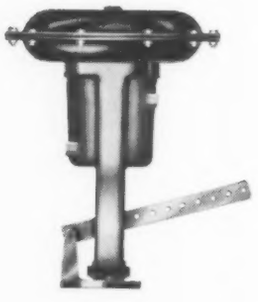
AREA TYPE ELECTRIC FLOW TRANSMITTER measures flow of oil, or other viscous fluids. Not subject to clogging or abnormal wear on the meter or orifice.

You CAN beat



***TEL-O-SET* MINIATURE INSTRUMENTS** for centralized graphic panel operation. These recording, indicating and controlling instruments are designed for maximum economy and convenience in installation, operation and maintenance.

DIAPHRAGM CONTROL VALVE—SERIES 800 for fuel, air or steam flows. Wide band proportional control.



AIR-O-MOTOR DIAPHRAGM MOTOR OPERATOR for operation of valves, dampers. Lever or thrust action available, and spring or springless designs cover a wide range of power requirements.

ON OPEN HEARTH FURNACES—Fuel savings, on the open hearth furnaces of the Alan Wood Steel Co., Conshohocken, Pa., nearly repaid for the Honeywell Control System (in inset) in the first year of operation. All available byproduct gases of the coke ovens are mixed with the minimum amount of base fuel for correct Btu output; and fuel flow is totalized and continuously recorded on charts.

the high cost of fueling

with Honeywell Instrumentation

Instrumentation can give you more heat per fuel dollar by increasing heat efficiency . . . by making practical the use of byproduct fuels . . . and by permitting a switch in base fuel whenever outside prices and supply conditions make such a shift profitable.

Honeywell Instrumentation can do more than measure or control a specific operation. It will enable you to increase production . . . up-grade quality . . . get more accurate cost accounting data . . . make better use of manpower . . . improve operating techniques . . . and increase profits. Whether it be a program for more efficient use of present equipment, or for a completely new plant, instruments can play a vital part in the success of your company's operation.

Honeywell, world's largest manufacturer of automatic controls, can make instrumentation pay dividends in your plant—whenever you're ready.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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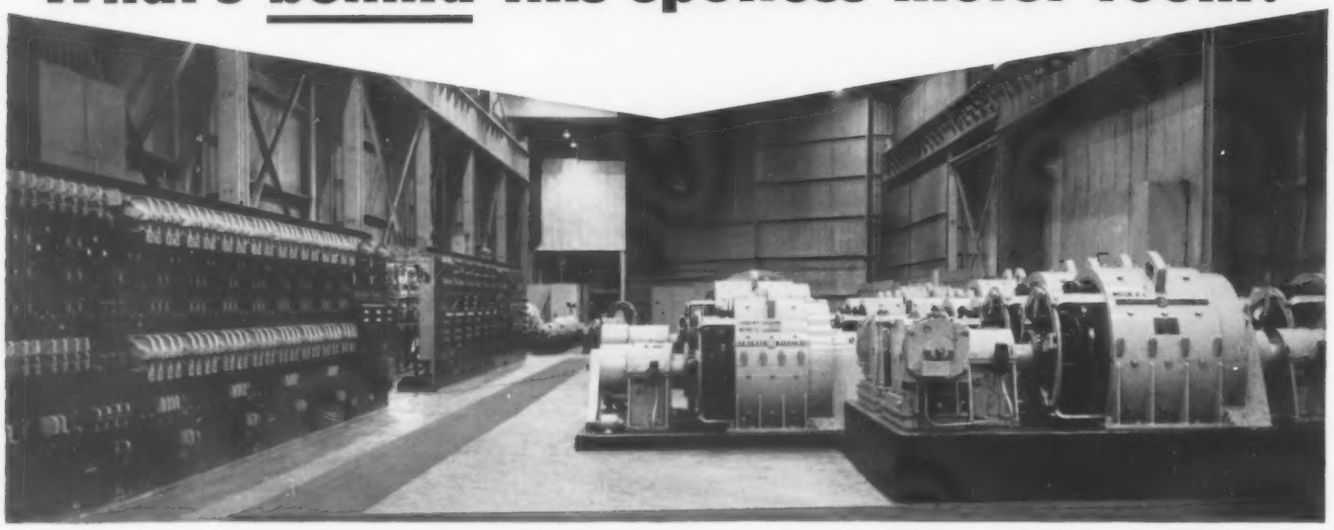
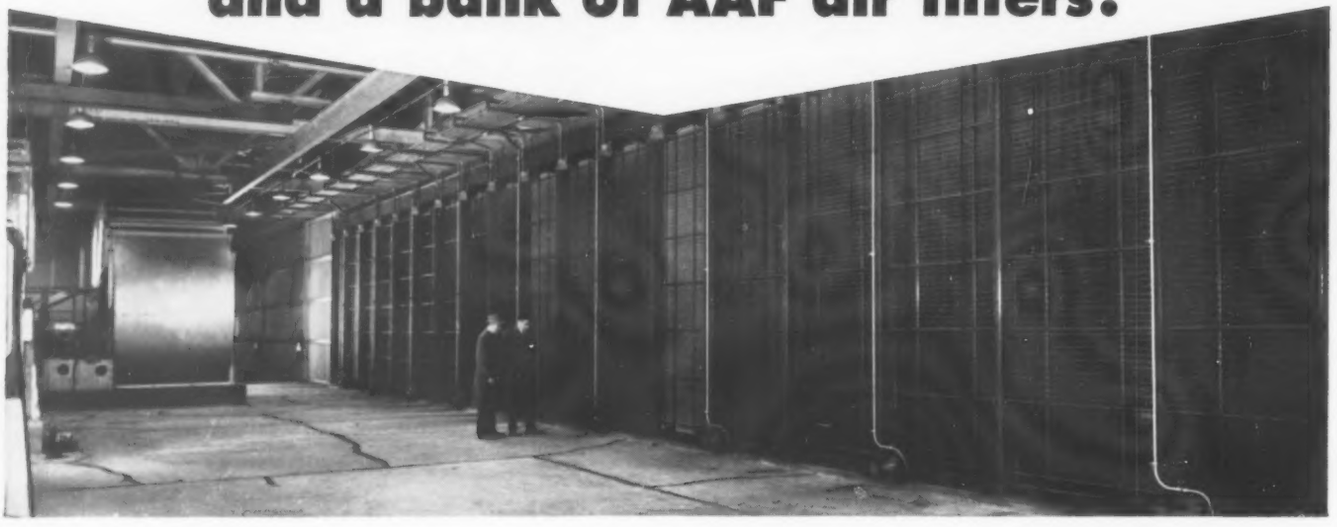
Honeywell

First in Control

What's behind this spotless motor room?



Sound investment-protection planning, and a bank of AAF air filters!



AAF ROLL-O-MATIC filters protect vital equipment for Weirton Steel Company

Weirton Steel didn't give dust a chance to hamper the functioning of their massive motor room equipment. From the complete AAF filter line, they selected the automatic, renewable-media Roll-O-Matic . . . installed 30 sections totalling 887,000 cfm.

Their reasons: the same reasons that have led to the installation of Roll-O-Matics at 2,100 locations since 1954 — (1) completely automatic operation, (2) maintenance as simple as changing the film in a camera, (3) high cleaning efficiency, and (4) large dust-holding capacity.

For more reasons, call your nearest AAF representative, or write direct for Roll-O-Matic Bulletin 248C.

AAF
herman nelson

American Air Filter
COMPANY, INC.

302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

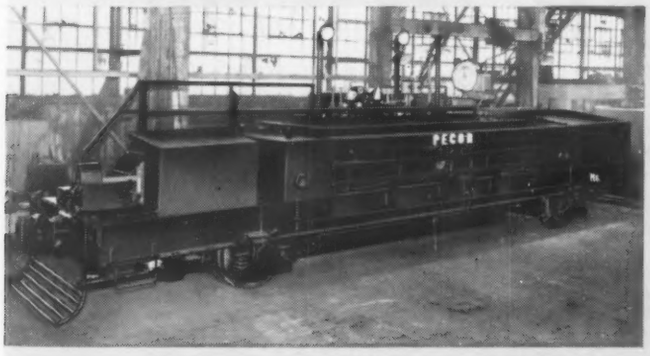
VISIT AAF BOOTHS
513 and 514
1958 Iron and Steel Exposition
Cleveland Public Auditorium
September 23-26

Building a New Future into your Equipment

—a PECor SPECIALTY

You can save up to 50% of capital investment by *modernizing* and enlarging existing steel plant equipment the PECor way.

Example A: (*above*) Steel plant ladle—re-engineered and rebuilt—original capacity 250 tons—NOW 300 tons.



Example B: (*left*) A 320 cu. ft. blast furnace scale car rebuilt to handle 380 cu. ft. of sintered ore.

PECor—a leading designer and producer of heavy steel plant equipment for over 75 years . . . specializes in the re-engineering and rebuilding of existing equipment *of all makes.*

If you would like to enlarge or modernize at a fraction of new cost—see PECor.

ENGINEERS
FABRICATORS

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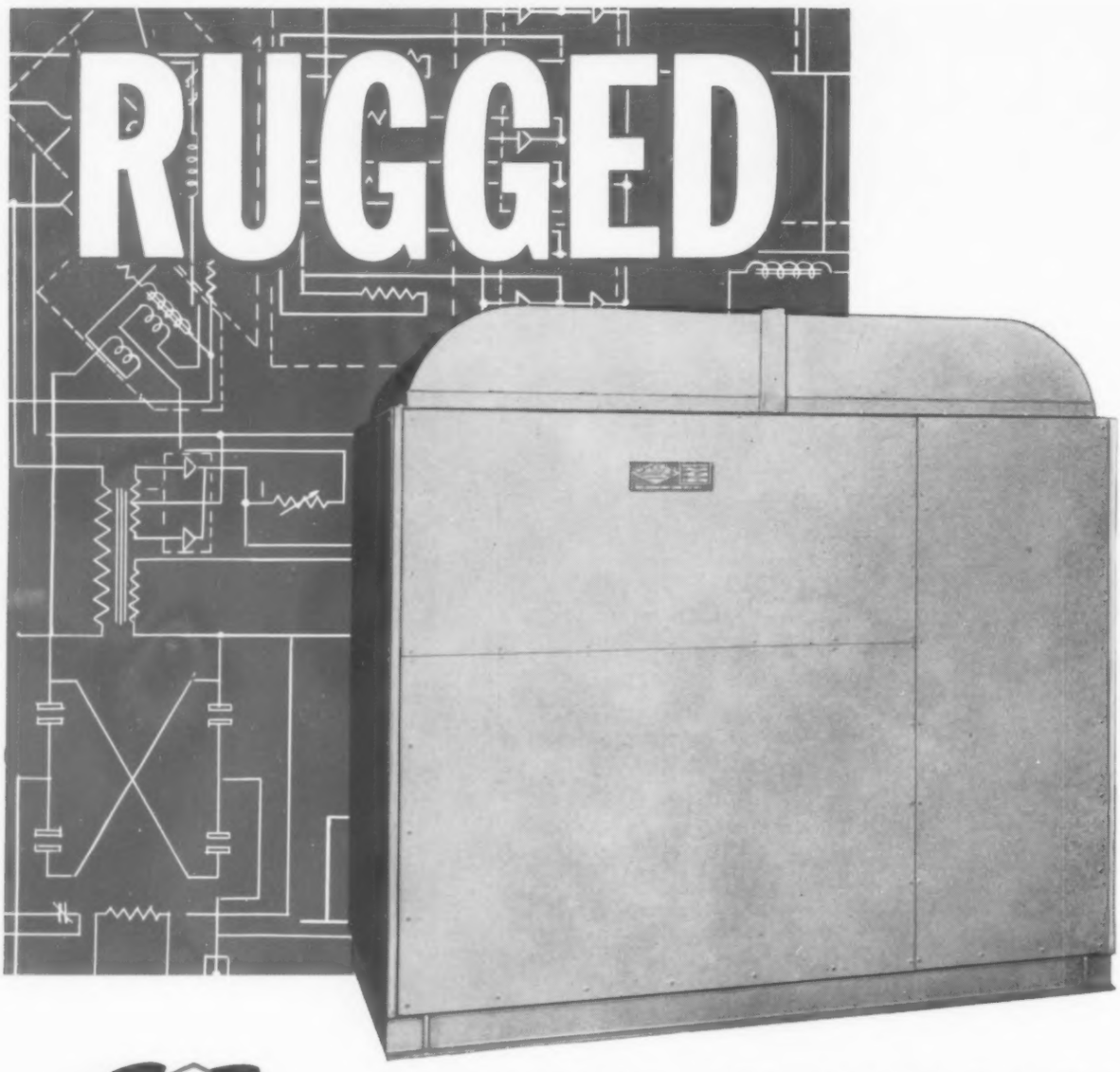
PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PA.

OTHER STEEL PLANT EQUIPMENT WE BUILD

Blast Furnaces • Scrap Cars • Slag Cars
Oxygen Converters • Bessemer Converters
Hot Metal Mixers • Ore Transfer Cars
Ladles • Jack Cars • Ladle Transfer Cars
Ingot Cars • Mixer Cars • Thermo Metal (Bottle) Cars • Scale Cars

RUGGED



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CUSTOM ENGINEERED
RECTIFICATION
GERMANIUM • SILICON • SELENIUM

Underwater for three days during a recent New England flood,* two Sel-Rex Rectifiers operated perfectly after a superficial cleaning. Now we don't recommend running Sel-Rex Rectifiers underwater—but this incident typifies the rugged dependability you get with all Sel-Rex Metallic Power Rectifier Equipment.

Our fully illustrated "GUIDE" to METALLIC POWER RECTIFIERS gives details on semiconductor power conversion equipment and full systems for most industrial AC to DC applications. Whether your interest is practical or academic, this "GUIDE" will become your most dependable source of DC power information. Please request your FREE copy on your company letterhead.

*We do make a model for underwater operation.

Rectifier Division

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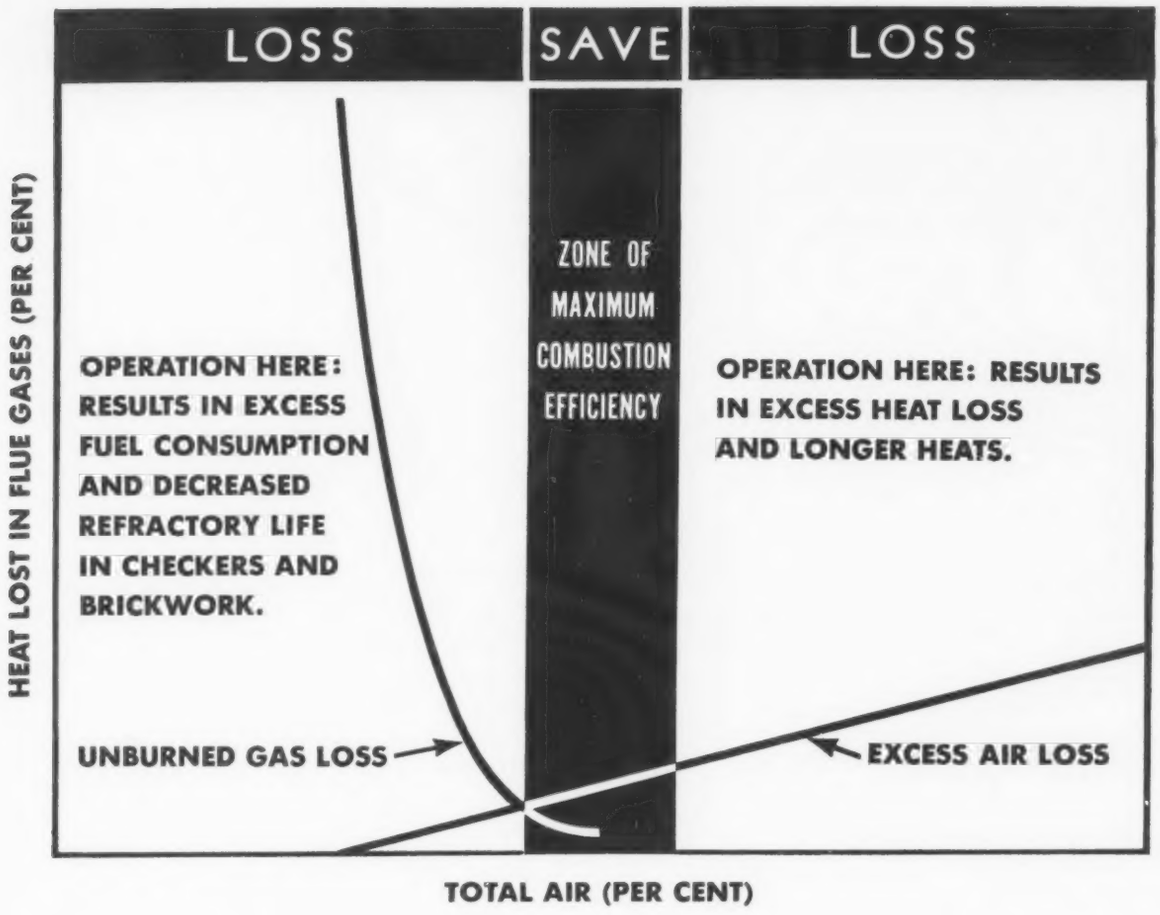
Representatives in Principal Cities

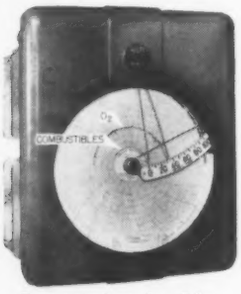
"Complete Semiconductor Power Conversion Systems for any AC to DC application."

To Save Fuel . . . Analyze for Combustibles, Too . . .


LOSS
SAVE
LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
OPERATION HERE: RESULTS IN EXCESS FUEL CONSUMPTION AND DECREASED REFRACTORY LIFE IN CHECKERS AND BRICKWORK.
OPERATION HERE: RESULTS IN EXCESS HEAT LOSS AND LONGER HEATS.
UNBURNED GAS LOSS
EXCESS AIR LOSS
HEAT LOST IN FLUE GASES (PER CENT)
TOTAL AIR (PER CENT)

Standard Steel Works finds oxygen and combustibles analysis saves fuel; gives closer control of open hearths.

Results—Fuel conversion was completed without firing difficulties . . . and closer supervision of open hearth operation from a fuel-air ratio standpoint was realized. These were immediate results reported by Standard Steel Works Division of Baldwin-Lima-Hamilton Corporation, Burnham, Pa.



Oxygen and combustibles on same chart

The conversion from oil to oil-natural gas firing was tried first on one of five open hearths. Continuous analysis of combustion gases was added at the same time. The Bailey Analyzer-Recorder played a dual role in training operators, and giving engineers a fast check on the efficiency of the firing system.

Big Help—Part of the credit for success of the changeover goes to the gas analysis system. Here's why—

1. It measures the percentage of oxygen in the flue gas, which indicates the excess air loss.

2. It measures the percentage of combustibles in the flue gas, which is a check on the mixing efficiency of the burners.

3. It provides a continuous and permanent record of both variables on one chart, which, in addition serves as an operator's guide.

Money's Worth—The gas analysis system has been trouble free from the start (July 1957). Operators quickly mastered the technique of oil-gas firing with the help of the analyzer charts. Pleased with the results, Standard Steel Works is installing the same system on its four other open hearths.

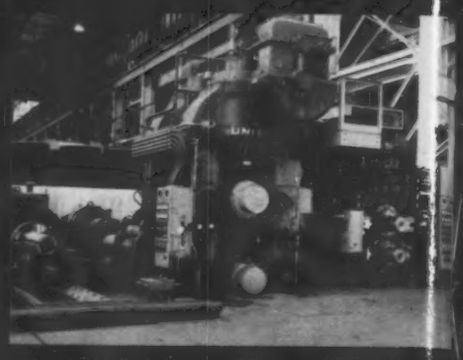
Write for Performance Report OH11-1 for complete details on this installation. S12-1

IRON AND STEEL DIVISION

BAILEY METER COMPANY

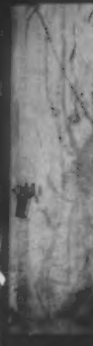
1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



TSP

TSP »»»»»»» at K



"TOOL STEEL PROCESS" HARDENED PRODUCTS will reduce costs because they last many times longer than other products, eliminating the necessity of frequent replacements. They save time because it is seldom necessary to stop a machine to replace a TSP product. TSP hardened products, now more than ever before, are in service at the Kaiser Steel Corp., Fontana, California.

here's why

The K
produ
Whee
many
ing do
time.
specia
depth
life. Th
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KAISER STEEL

The Kaiser Steel Corp. is a big user of TSP products including Gears, Pinions, Rolls, Wheels and Screwdown Screws. We have many service records on TSP products showing dollar savings in maintenance and down-time. TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility gives maximum strength. You receive an absolutely positive written guarantee that TSP products give a longer life in the same service than any other product. Complete information on the many TSP products for the Steel Industry available on request.

TOOL STEEL

GEAR AND PINION CO

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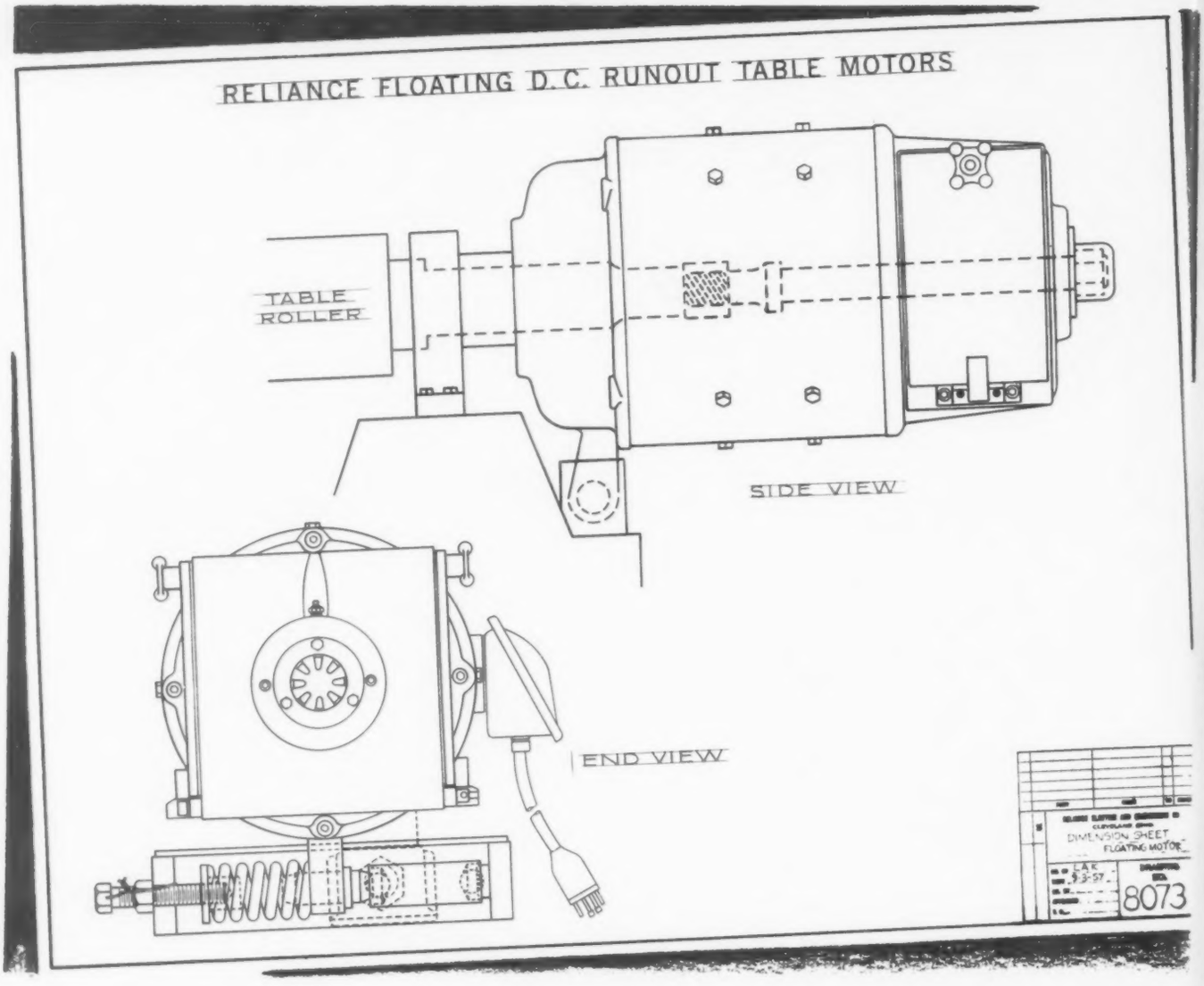
The Standard of Quality Since 1909
for Gears, Pinions, Rolls, Wheels and Other Hardened Products.



Reliance runout table motors cut installation and maintenance costs

Reliance Hollow Shaft, floating motors are easy to install. They require no special pedestals or flexible couplings.

The hollow shaft motors fit right over the table-roller shaft. No special alignment is required. Warpage and backlash compensation are handled by the heavy tie-down spring. Not only are coupling maintenance and lubrication eliminated, but a much greater degree of roller misalignment can be tolerated.

Reliance Floating motors are designed and built specifically for runout table service. They are available with a wide range of speeds and out-put torques. For complete information contact your local Reliance Representative, or write for Bulletin No. F-2051. C-1587

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 119A CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in principal cities

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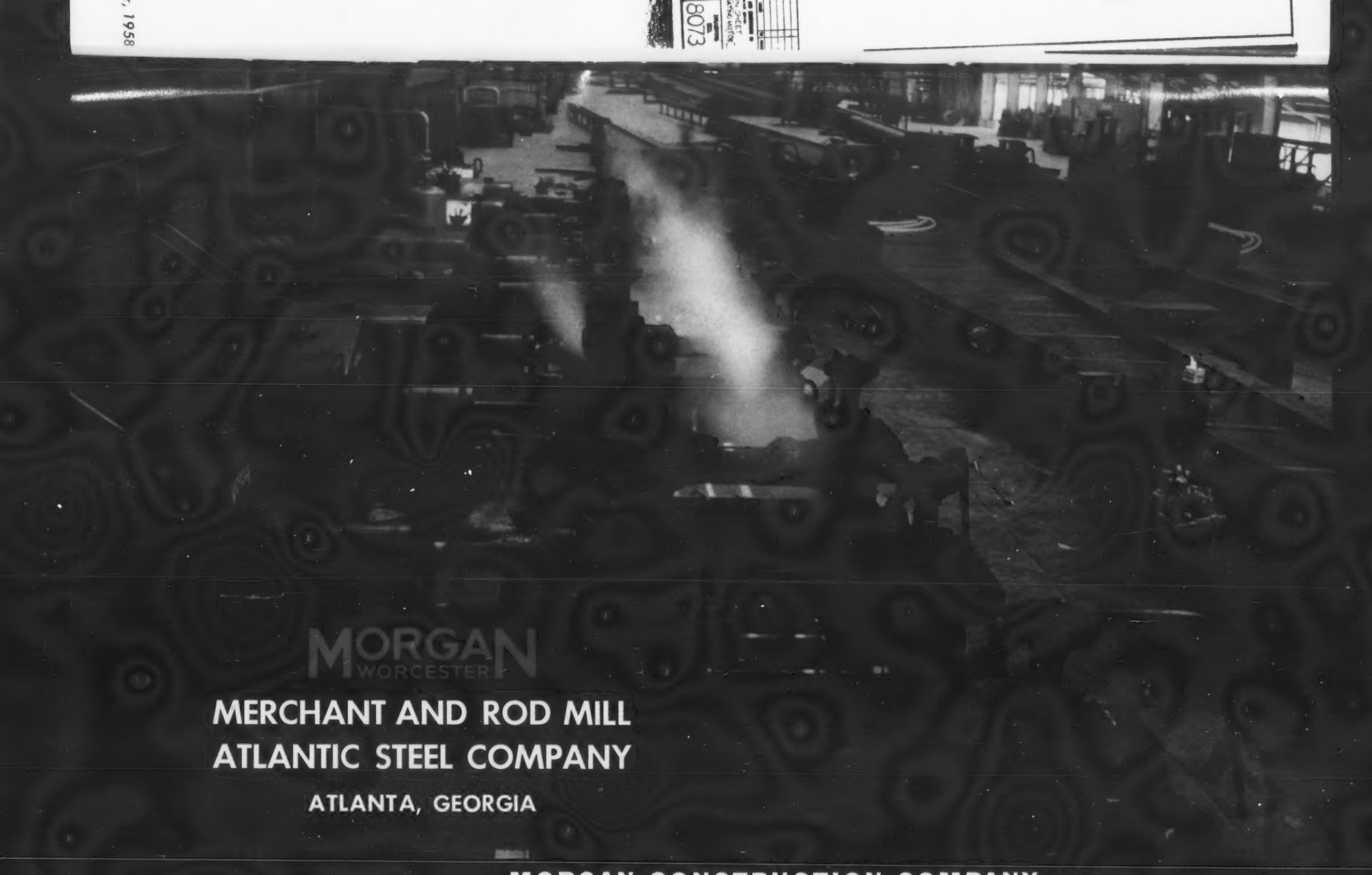


MERCHANT AND ROD MILL
ATLANTIC STEEL COMPANY

ATLANTA, GEORGIA

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.
ROLLING MILLS • MORGOIL BEARINGS • WIRE MILLS • REGENERATIVE FURNACE CONTROL • EJECTORS • GAS PRODUCERS
S. S. Rickley, Representative, 300 Cedar Blvd., Pittsburgh, Pennsylvania

THIS MAN CAN ADD TO YOUR PROFIT PICTURE. This is a Dowell service engineer—on the job. His knowledge and abilities in chemical cleaning can help you to greater profits. Recently, an eastern corporation used Dowell Service for its boiler cleaning maintenance. Dowell's service engineer studied the problem, did the job. His use of chemical solvents in cleaning tubes and other metal surfaces was effective. On the basis of Dowell Service, this company will realize improved profits of $440,000.

There are three ways you can clean your plant equipment: *Mechanically* with your own crews—inefficient, time consuming and expensive in today's industrial pace. *Chemically* with your own crews—again inefficient and unprofitable because of heavy payroll and the personnel's lack of qualification. Or with *Dowell Service,* the modern chemical cleaning method.

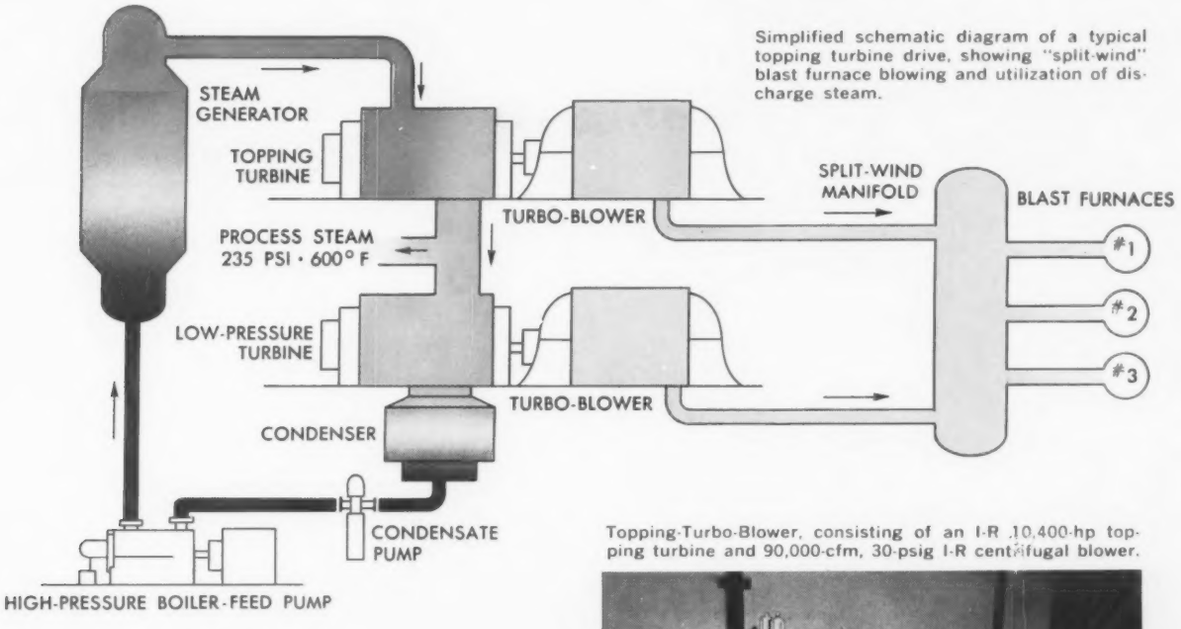
With Dowell Service you receive the benefits of more than fifteen years experience in chemical cleaning—plus special equipment, chemicals, research and trained personnel. You pay one charge, get an efficient job, handled by knowledgeable people.

Every industry can profit from Dowell Service. Ask your maintenance and operating engineers if they have thoroughly investigated the profit possibilities of using Dowell Service. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa 1, Oklahoma; 165 offices and stations to serve you.

Chemical cleaning service for industry DOWELL

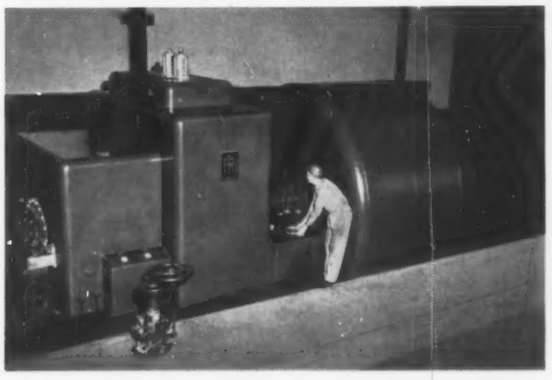
New I-R TOPPING-TURBO-BLOWER

saves 75% in cost of blast-furnace air!



Simplified schematic diagram of a typical topping turbine drive, showing "split-wind" blast furnace blowing and utilization of discharge steam.

Topping-Turbo-Blower, consisting of an I-R 10,400-hp topping turbine and 90,000-cfm, 30-psig I-R centrifugal blower.



Where conditions permit, the Topping Turbine can drastically reduce blowing costs by using only the low-cost high-pressure fraction of boiler output and discharging usable steam for other mill services

THE USE of a topping turbine to reduce the cost of process steam has been well demonstrated in the paper, petroleum and food processing industries. Now, to extend these advantages to steel-mill applications, Ingersoll-Rand has developed and perfected a topping turbine for driving blast-furnace blowers or other large-capacity centrifugal compressors. The first of the new units—a 10,400-hp turbine driving a 90,000-cfm Ingersoll-Rand blower—is shown above installed in a midwestern steel company's blast furnace plant.

The topping turbine is designed to operate on high-pressure, super-heated steam at 850 psi, 850F, and to exhaust steam at approximately 235 psi, 600F—for operation of additional condensing steam turbines and for supplying process steam requirements.

In steam generation, the cost of raising the temperature and pressure from 235 psi and 600F to 850 psi and 900F, adds only about 10% to the total steam cost. And with a topping turbine, only this additional 10% is chargeable as power cost for the driven blower. Thus where conditions permit, the topping turbine makes possible a saving in air-power cost of as much as 75% compared to a conventional condensing-turbine drive.

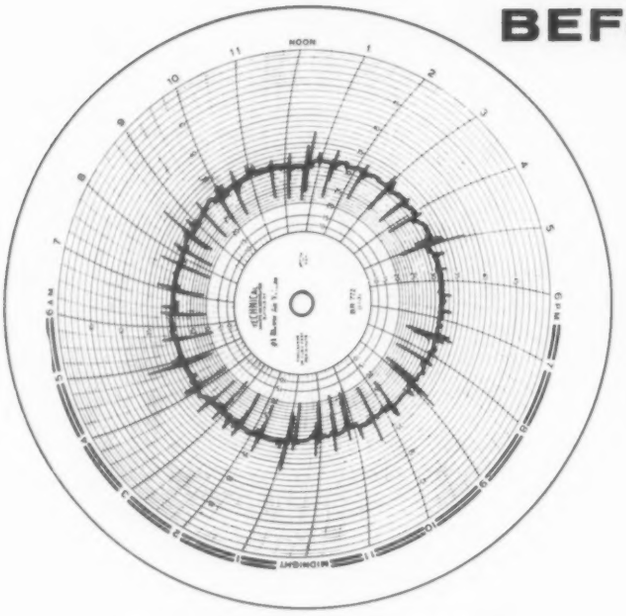
Your Ingersoll-Rand blower engineer will be glad to discuss your specific requirements and help you determine whether or not a Topping Turbine or Topping-Turbo-Blower can be applied to advantage in your plant.

Ingersoll-Rand

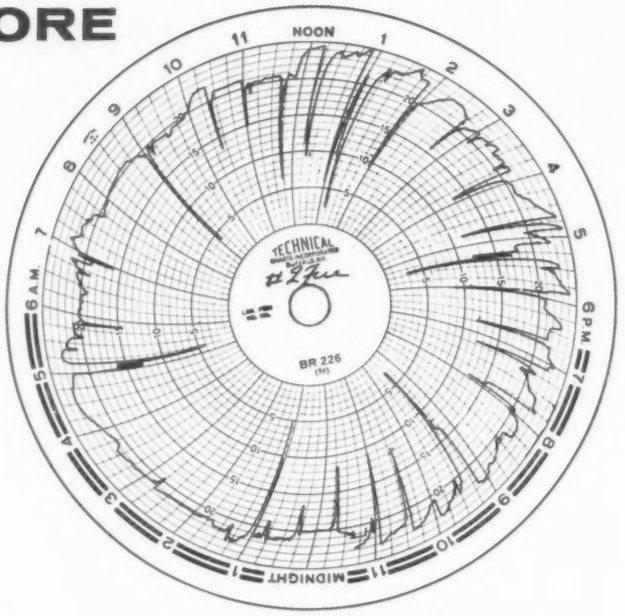
12-876 11 Broadway, New York 4, N. Y.

THERE'S NO SUBSTITUTE FOR EXPERIENCE IN ENGINEERED PRODUCTS

BEFORE



AIR FLOW TO FURNACE

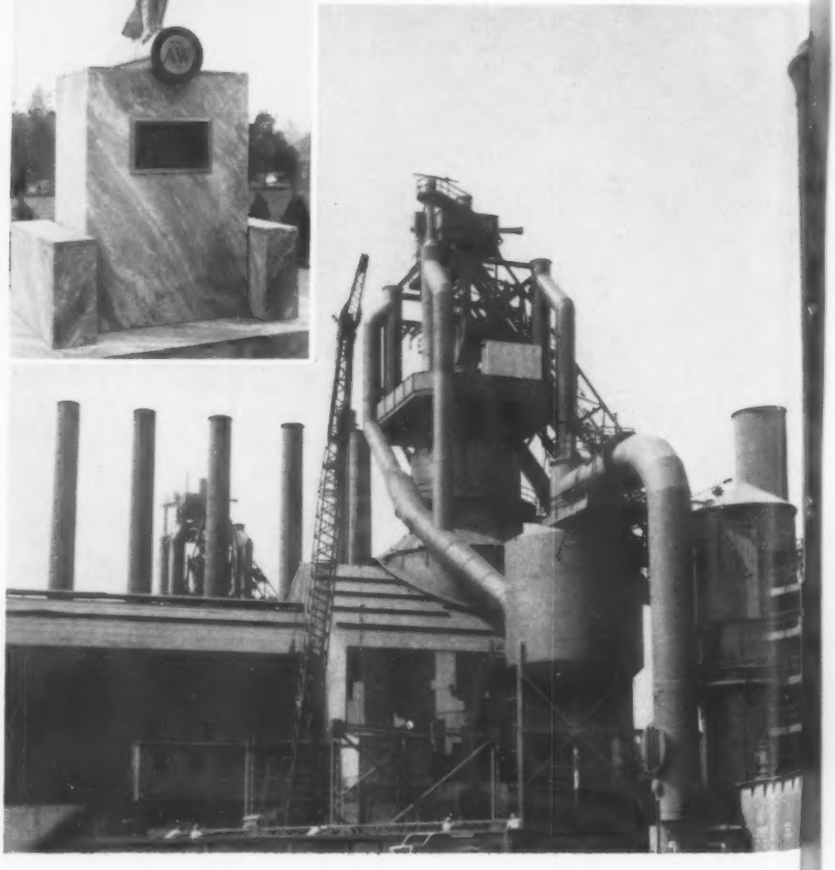


BLAST PRESSURE

HAGAN CONTROL MODERNIZES

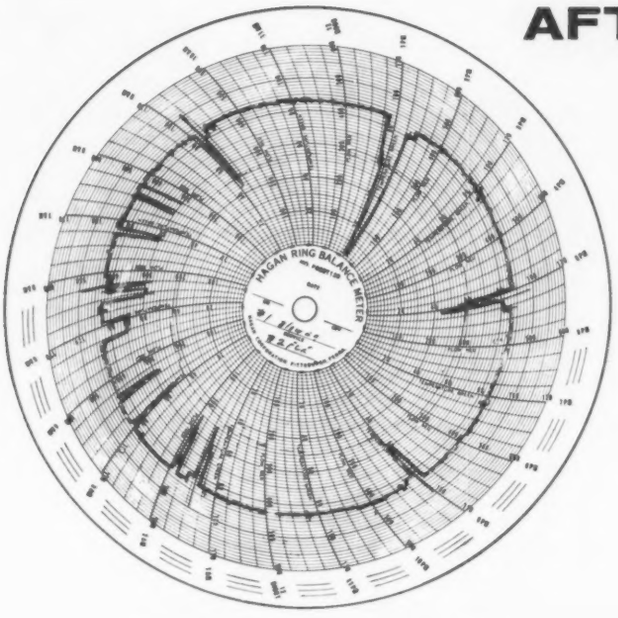
HAGAN BLOWER CONTROL PANEL provides one station for the normal flow set point and one station for the blast furnace checking set point, as well as a manual control for positioning the steam valve. Hagan controls on the turbine governor automatically maintain the blast flow as needed.

THIS MONUMENT at Alan Wood Steel Company symbolizes their record of producing fine metal products since 1826.

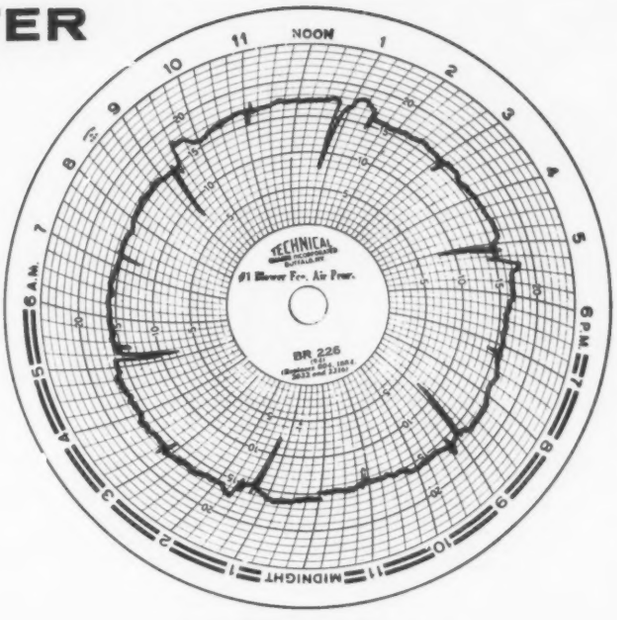


BLAST FURNACE NO. 2 at the Conshohocken, Pa., plant is delivering higher production with lower operating costs since the installation of Hagan blast furnace blower control system.

AFTER



AIR FLOW TO FURNACE



BLAST PRESSURE

1918 BLAST FURNACE BLOWER

New automatic system cuts costs, ups production at Alan Wood Steel Co.

Greatly improved performance, higher production, and lower operating costs have resulted from the installation of a Hagan blast furnace blower control system on Furnace No. 2 at the Conshohocken, Pa., plant of the Alan Wood Steel Company.

As the charts above illustrate, the new control automatically maintains a steady flow of air to the furnace despite frequent changes in furnace burden.

According to Alan Wood officials, furnace operation has been more steady with this constant blast flow, and they have achieved a corresponding saving in operating time and money.

Even though the blower for Furnace No. 2 has been operating since 1918, the new controls were quickly, easily installed without extensive design changes or installation delays.

Additional time and production is saved by the alternate Hagan control panel located in the blast furnace cast house—200 feet from the blower room—which allows wind to be controlled from either place. Interlocks assure complete safety during control transfer. The cast house operator is now able to make wind changes immediately, without experiencing the delay caused in the past by signalling between cast house and blower room.

Hagan controls and control systems are designed to help you get the most out of your present equipment. A small investment in modern controls can often allow large capital investment to be indefinitely postponed—with increased operating efficiency and profits.

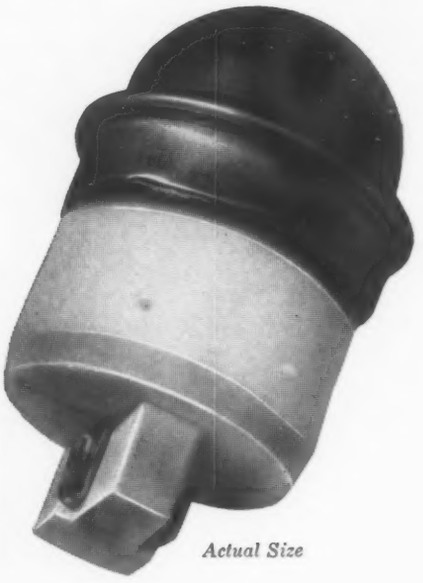
Find out more. Contact John E. Duesing, Hagan Chemicals & Controls, Inc., Hagan Building, Box 1346, Pittsburgh 30, Pa., or your nearest Hagan Sales Office.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

Another major advance ...

THE L&N EXPENDABLE IMMERSION THERMOCOUPLE CARTRIDGE



Actual Size

Here is a unique development in bath pyrometry for open-hearth and electric-arc furnaces. Shop-tested and proved in the plants of major steel producers, this one-shot, throwaway couple gives maximum accuracy, simplicity and convenience.

The L&N Expendable Cartridge assures:

New-thermocouple accuracy *for each reading,* since each couple is new . . . uncontaminated

Reliable performance *for each immersion,* since the couple is protected from slag and floating solids by its sheet-steel jacket, which melts away in the metal

High-speed measurements — reading is completed within 5 seconds of immersion

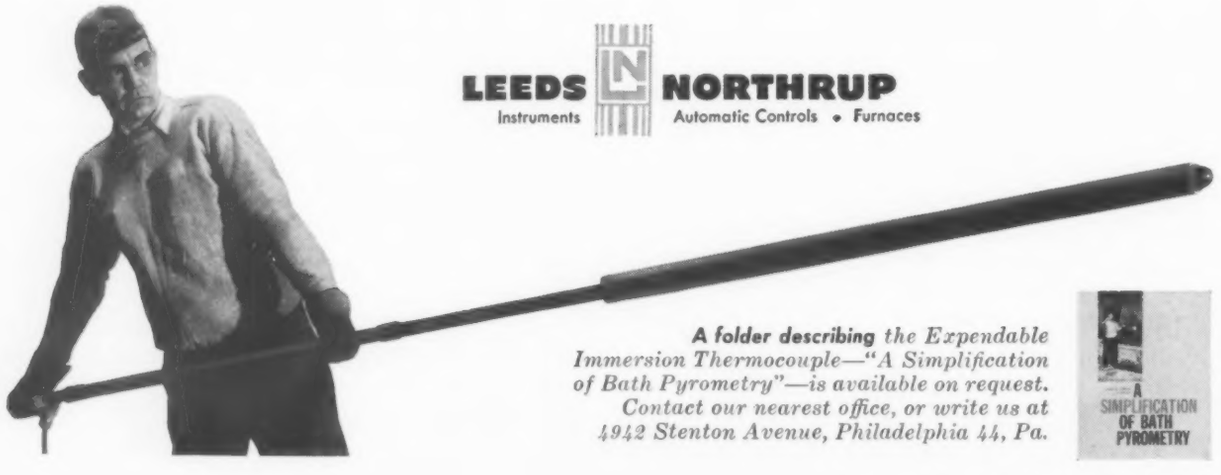
Simplicity of operation — anyone can take a reading single-handedly—anyone can replace the Expendable Cartridge in seconds

Minimum maintenance, since the immersed parts are discarded after a reading . . . no skulls or slag on the assembly to contend with . . . no checking required . . . no repair facilities needed

Low initial investment — holder assembly consists mainly of low-cost standard pipe with a few simple fittings

Simplification of purchasing and inventory, due to the limited number of parts.

Why not check the advantages of this new equipment right in your own shop? No other demonstration can be more convincing.



LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces

***A folder describing** the Expendable Immersion Thermocouple—"A Simplification of Bath Pyrometry"—is available on request. Contact our nearest office, or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.*

Crane control so exact you can polish your car

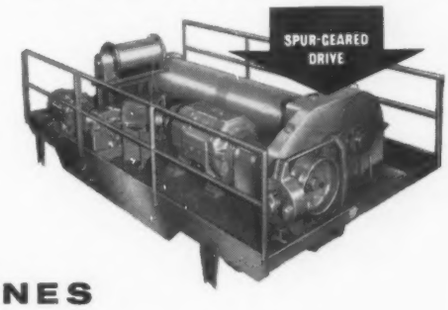
Polishing a $5,000 Mercedes-Benz with a cloth wrapped around a crane hook takes perfect control. Foolish idea? Not really. The hot and cold steel you handle and the equipment nearby are worth many times the cost of a quality car. That's why the total control provided by Shaw-Box is so vitally important to mills.

Shaw-Box Builds Cranes to AISE Specs or Your Own

You name the crane — any type, any size — Shaw-Box has the design and engineering experience and the facilities to meet AISE or your own specifications. You get total crane control that means everything in precision operation — everything in safety for man, load and crane. You can be sure of low maintenance and low power consumption. We assure complete dependability and highest performance regardless of service conditions.

Call in one of our engineers. He will gladly discuss specifications and tell you about our standard AISE designs for 5 to 500-ton cranes. Your inquiry is invited.

Prefer Spur-Geared or Worm-Geared Drive? Shaw-Box can meet AISE or your requirements exactly, whichever type is best for your application.



58K-2

MANNING MAXWELL & MOORE INC. TRADE MARK

"Shaw-Box"® CRANES

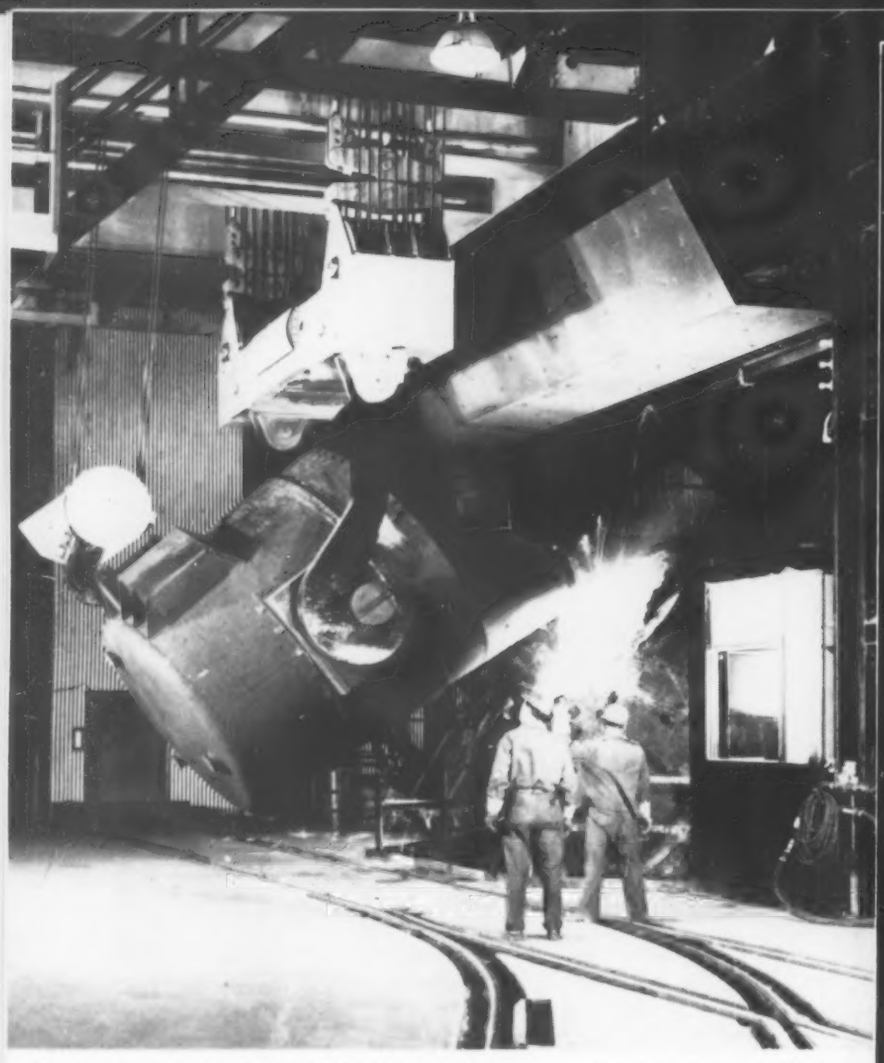
MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

388 W. Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, an 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



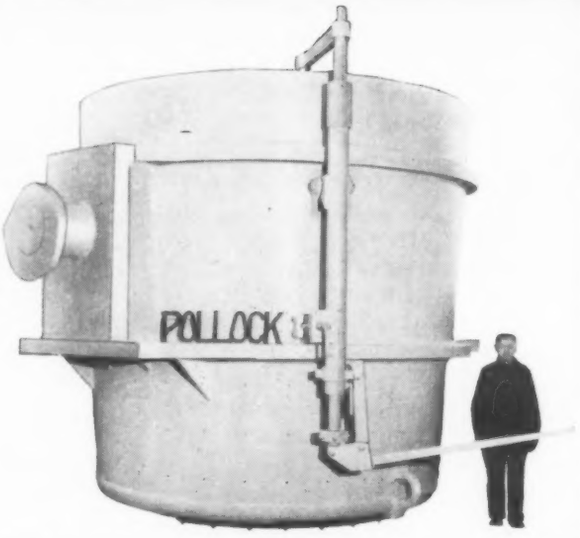
80-ton capacity Pollock ladle pouring iron charge into one of the new basic oxygen furnaces at the Aliquippa Works Division of Jones & Laughlin Steel Corporation.

The Industry's STANDARD

POLLOCK LADLES

Pollock ladles, like the one at left, are engineered for the jobs they do. This one was engineered and built for the Jones & Laughlin Steel Corporation, Aliquippa Works Division, to transport molten iron from the mixer ladle to the new basic oxygen process furnace. Its integral spout eliminates the old-fashioned runner used in most pouring operations, and the feet mounted on the ladle base make the ladle free standing. Pollock also built the ladles to receive the steel from the new furnaces. When you plan new facilities or increased capacity in your present plant, consult the Pollock engineers about your ladles. They'll work with you to develop new highs in efficiency and safety.

385-ton capacity open hearth ladle built by Pollock is the world's largest. It stands 17' 3-½" tall.



100-ton capacity all-welded electric furnace ladle by Pollock. All-welded construction cuts ladle weight—increases payload.

THE WILLIAM B. POLLOCK COMPANY

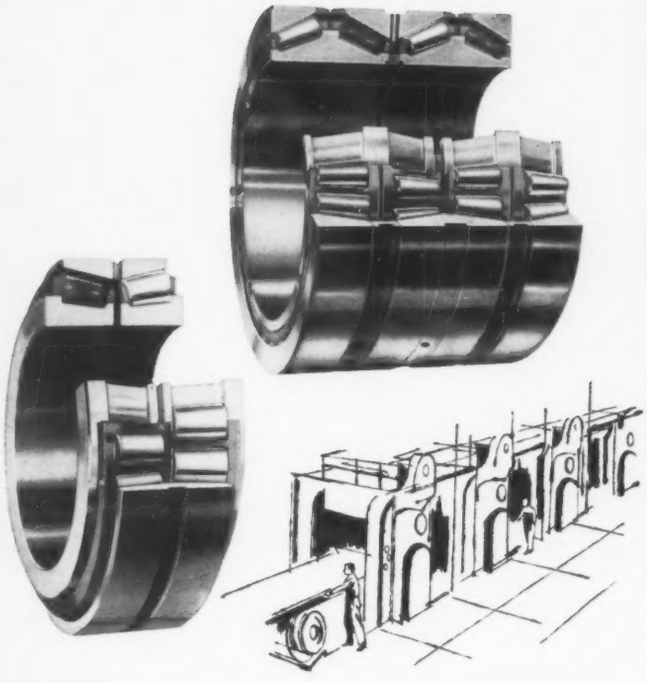
YOUNGSTOWN, OHIO

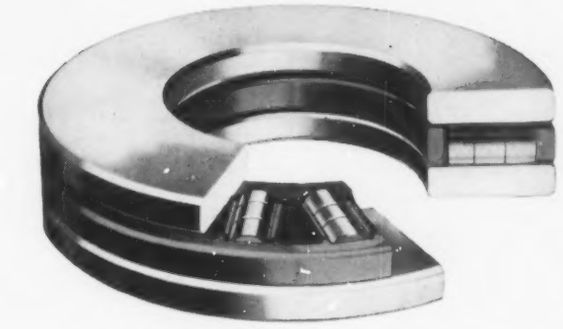
ASSOCIATED IN GREAT BRITAIN WITH ASHMORE, BENSON, PEASE & CO.

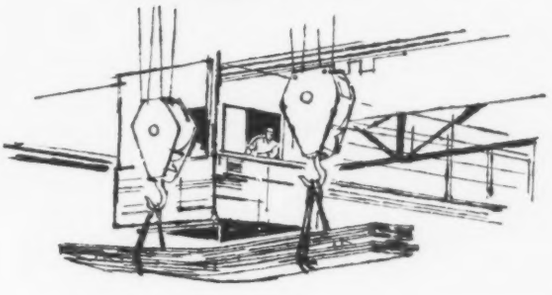
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

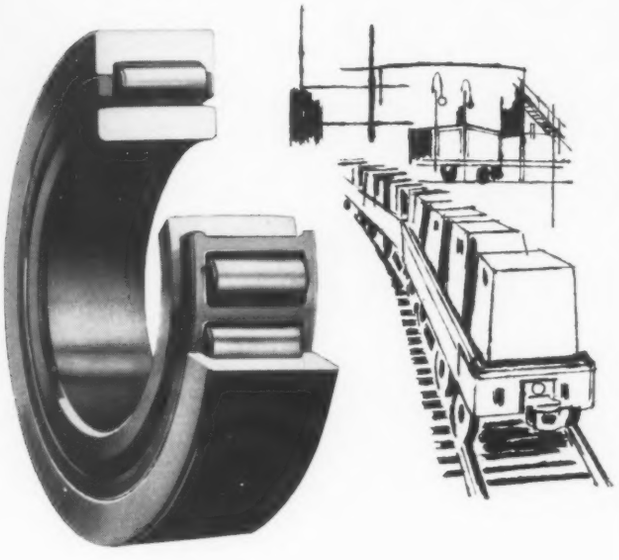
POLLOCK
Since 1863

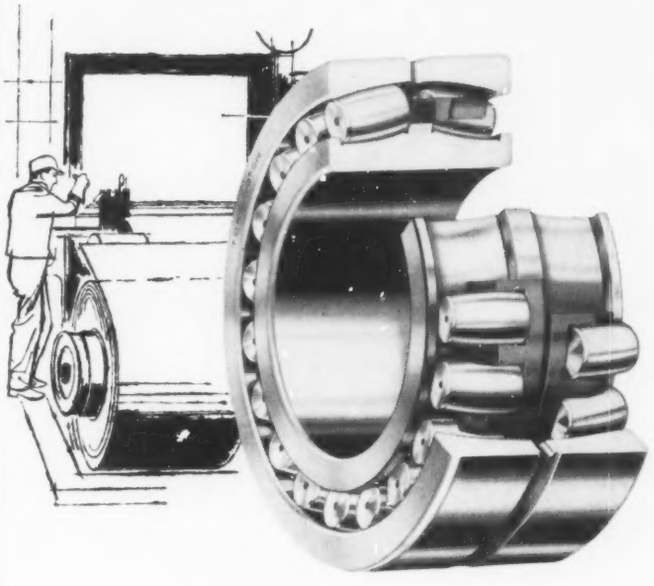
BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES











TORRINGTON BEARINGS FILL THE BILL ALL THROUGH THE MILL

Torrington offers every basic anti-friction bearing to meet specific requirements of steel mill applications . . .

TORRINGTON ROLL NECK BEARINGS, two-row and four-row, solid and pin-guided tapered roller, for every type of service in work roll, back-up roll and back-up thrust applications.

TORRINGTON ROLLER THRUST BEARINGS for mill screw downs and crane hook service.

TORRINGTON CYLINDRICAL ROLLER BEARINGS for ingot car service.

TORRINGTON SPHERICAL ROLLER BEARINGS for mill drives, runout tables, coilers, shears and other auxiliary equipment.

In every detail of design, construction and metallurgy, you'll find each Torrington Bearing unmatched for performance and service life. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

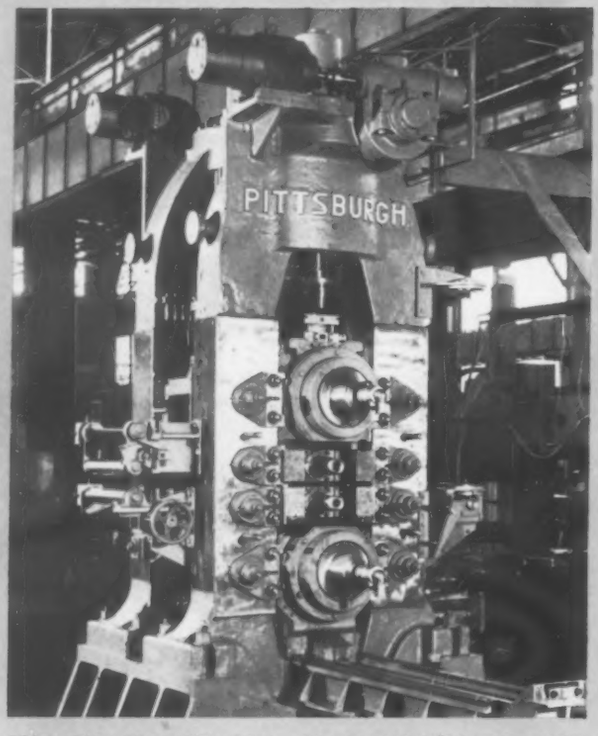
TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

Pittsburgh..

ENGINEERING & MACHINE DIV.



7½" x 21" x 20" or 21" x 20" combination 4 High/2 High Cold Mill.

Here is a heavy machine plant with a completely integrated steel foundry. PITTSBURGH ENGINEERING AND MACHINE DIVISION is serving Industrial America with products such as those illustrated on these pages.

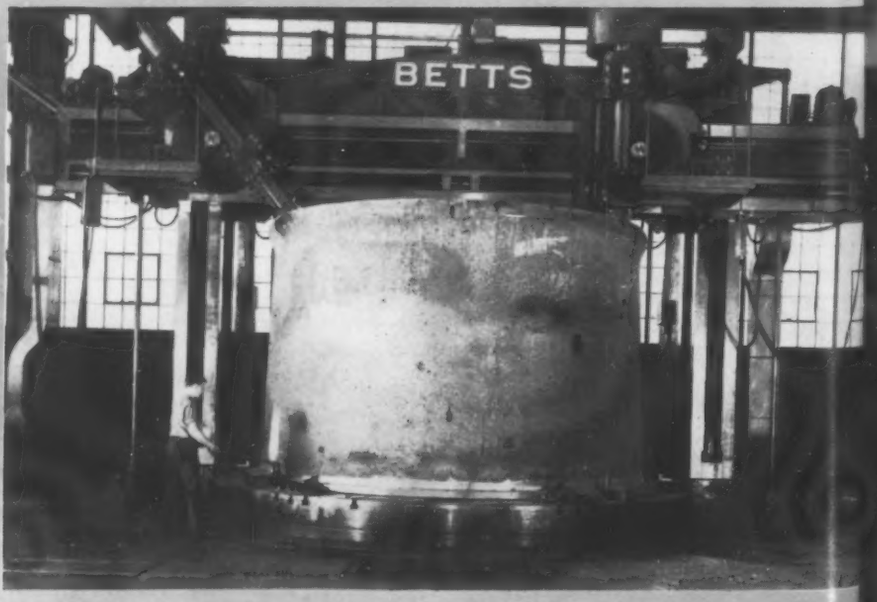
Recognition as a progressive company has been attained by keeping abreast of advanced industrial requirements with the addition of new equipment and technical personnel.

Directed by a service and quality-minded management, "PITTSBURGH" has the capacity to meet your most exacting requirements. Our facilities include open hearth and electrical furnace capacity of 60,000 tons per year and a superior complement of well diversified machine tools.

Our Engineers will serve you over a wide range of mill products from Auxiliary Equipment to complete Rolling Mills.

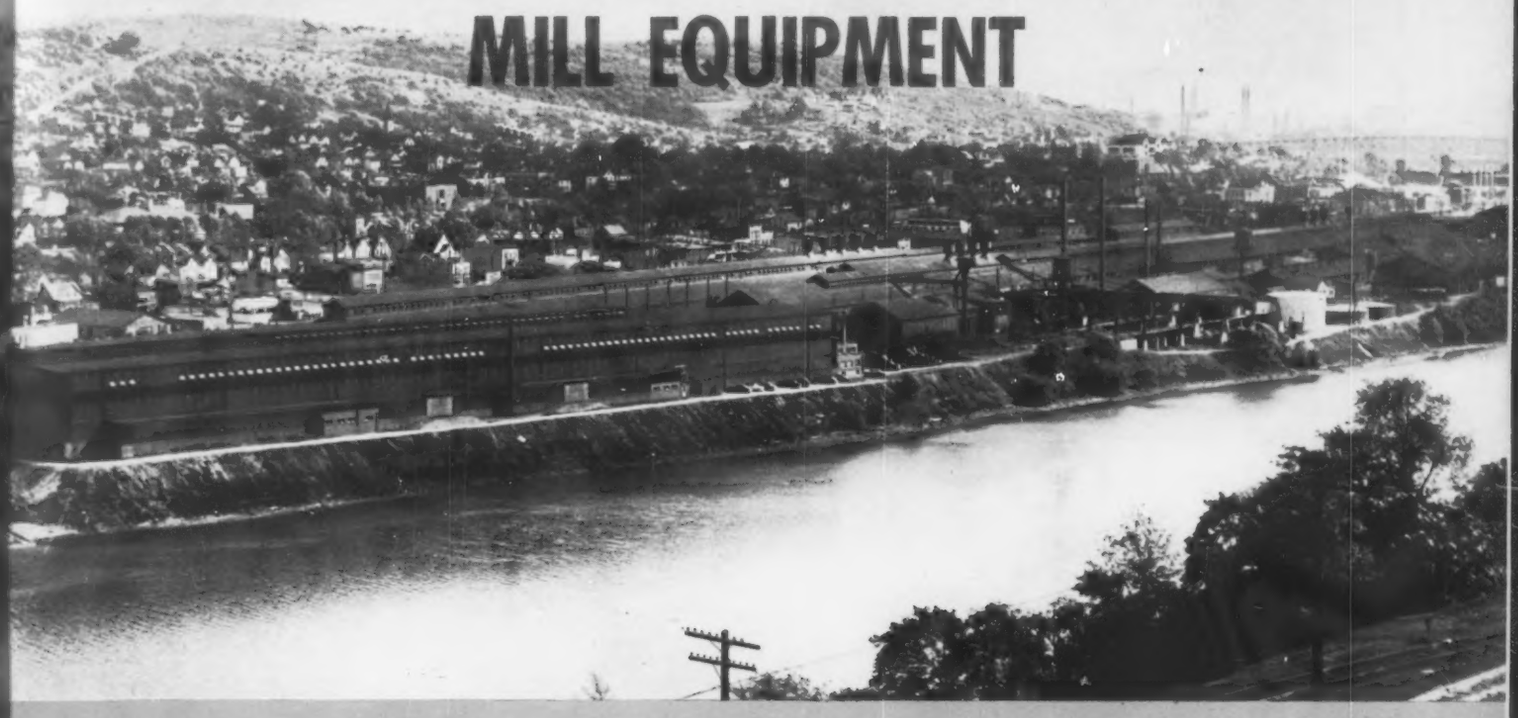
Pittsburgh
Engineering & Machine Div.
Division of Pittsburgh Steel Foundry Corporation
P. O. BOX 986, PITTSBURGH 30, PENNSYLVANIA
PLANT AT GLASSPORT, PENNSYLVANIA

450 ton Portable Ingot Stripper in operation. An exclusive product of Pittsburgh Engineering & Machine Division.



Giant steel casting produced by our foundry being machined on a 20' mill typifying a complement *well diversified machine tools* for machining a wide range of mill equipment.

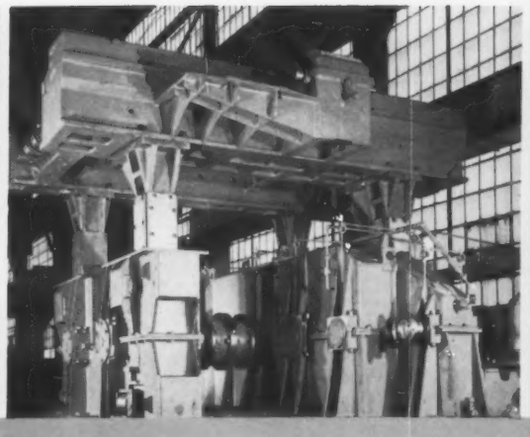
PRODUCERS of FERROUS and NON-FERROUS MILL EQUIPMENT



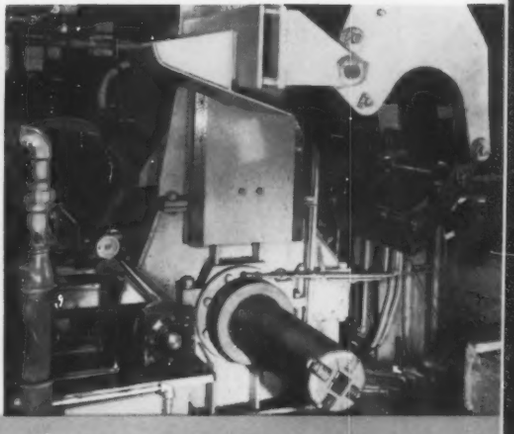
Some of our customers in heavy industry:

- ARMCO STEEL CORP.
- BETHLEHEM STEEL CORP.
- DETROIT STEEL CORP.
- GRANITE CITY STEEL CORP.
- JONES & LAUGHLIN STEEL CORP.
- KAISER STEEL CORP.
- McLOUTH STEEL CORP.
- REVERE COPPER & BRASS, INC.
- REYNOLDS METALS CO.
- UNITED STATES STEEL CORP.
- YOUNGSTOWN SHEET & TUBE CO.

Six stand 54" Hot Strip Mill featuring direct drive to all stands. First such installation in the U. S.



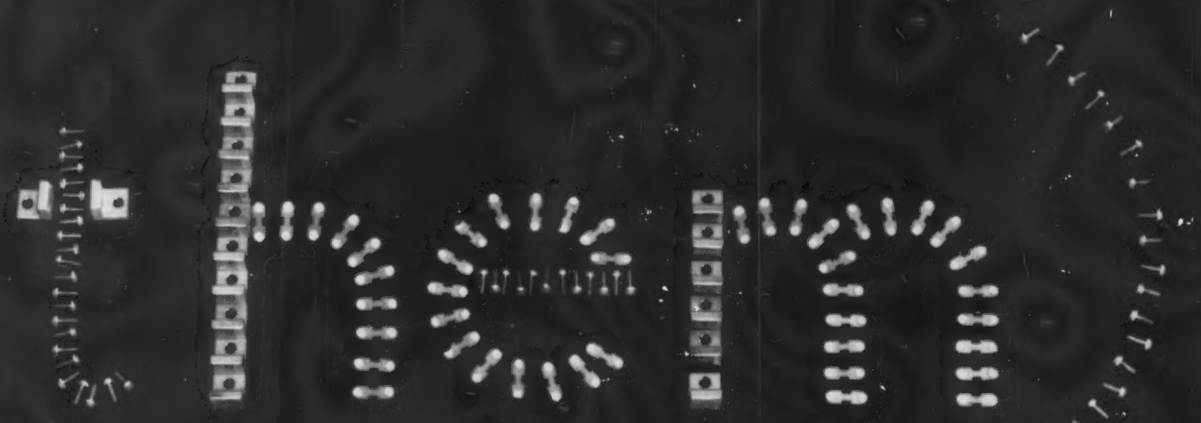
Half-million lb. Magazine Type Slab Depiler with end discharge. Designed to handle seven 21,000 lb. slabs.



Tension Reel and Belt Wrapper built for non-ferrous mill.

CLIMAX

Here are 244 overhead crane control parts that you'll never have to buy, inventory, or replace if you have P&H electronic "stepless" crane control!



These are wearing parts from the switch gear in an AC overhead crane. They are the most frequently replaced parts on most overhead cranes. Besides their original cost, they are a source of downtime, production delay, and maintenance labor costs.

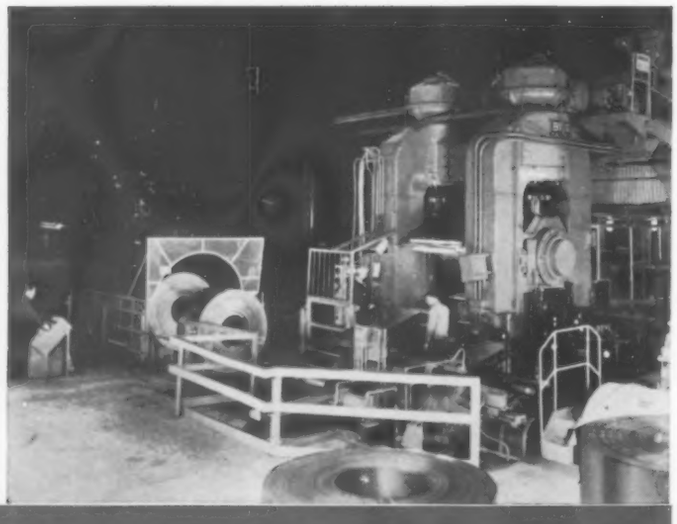
These parts have been eliminated from P&H's new Electronic "Stepless" Control and replaced with a wiring circuit requiring no maintenance.

Interested? Write Dept. 130G, Harnischfeger Corp., Milwaukee 46, Wisconsin.

58-130

P&H HARNISCHFEGER

... quality and service for 74 years



World's fastest four-stand cold reduction mill (3800 fpm—40 mph), it's also the world's most powerful (24,000 hp); features drives and controls on each roll. It is capable of rolling 70,000 tons of sheet a month, about double the capacity of the mill it replaced. The mill rolls coils weighing up to 60,000 lbs. and can produce sheets to 72″ wide.

Temper Mill is also important new performer at J & L's Cleveland Works. It is 19½″ and 53″ by 56″, has a top speed of 3500 fpm.

OPERATION "TURN-KEY" AT JONES & LAUGHLIN

From foundation to operation, Bliss assumed the role of "turn-key" contractor, supervising the construction and installation of the new cold rolling mills at the Cleveland Works. This involved—

- designing and building the world's fastest and most powerful four-stand tandem cold reducing mill
- designing and building a four-high temper mill
- supervising the modification and extension of the original cold rolling plant without disturbing operating equipment
- planning and supervising construction of the new annealing facilities for the Cleveland Works
- supervising sub-contracting of *all* equipment installation for the project.

To fulfill its contract, a staff of Bliss coordinators, amply backed by Bliss experience and J & L staffs, supervised the activities of many sub-contractors, keeping a hand in the thousand and one seemingly unrelated steps that go into the simultaneous modernizing of an old plant and the building of a new one. The assignment was considered "complete" when, in October of last year, Bliss "turned the key over" to J & L operating management.

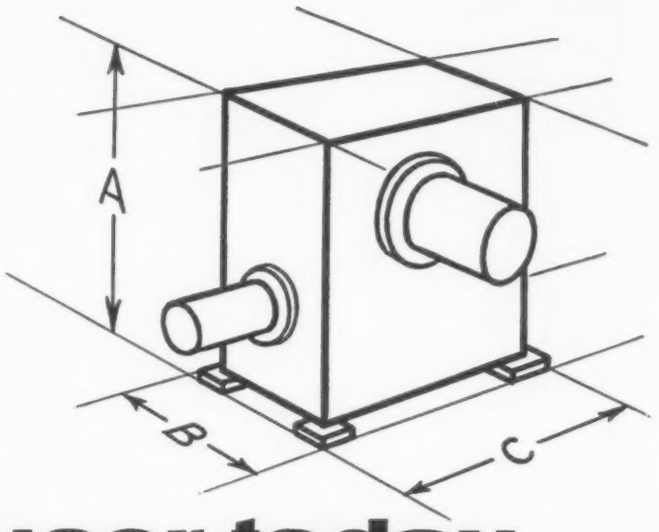
BLISS
SINCE 1857 ®

Bliss is more than a name... it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

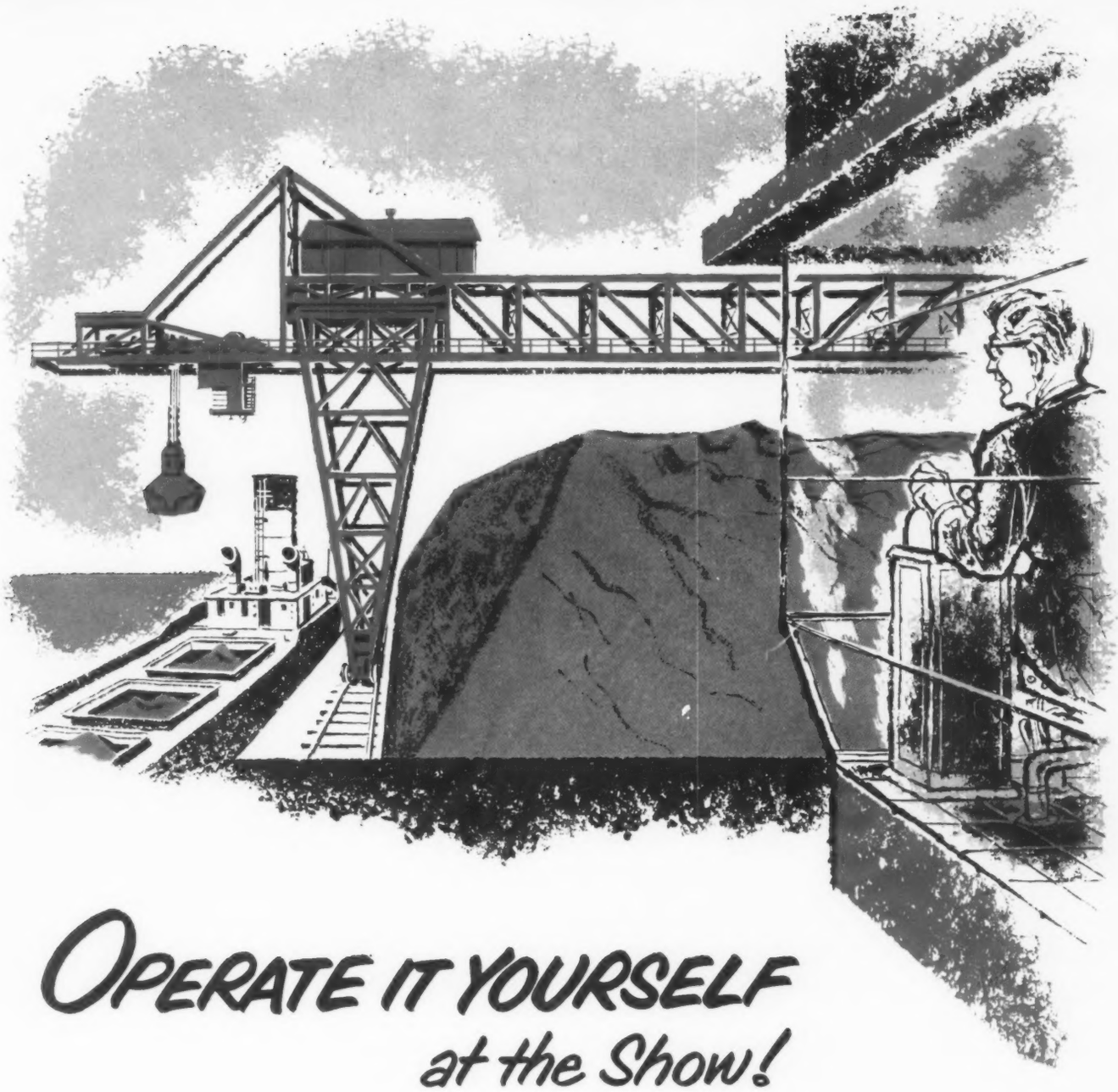
Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.



OPERATE IT YOURSELF
at the Show!

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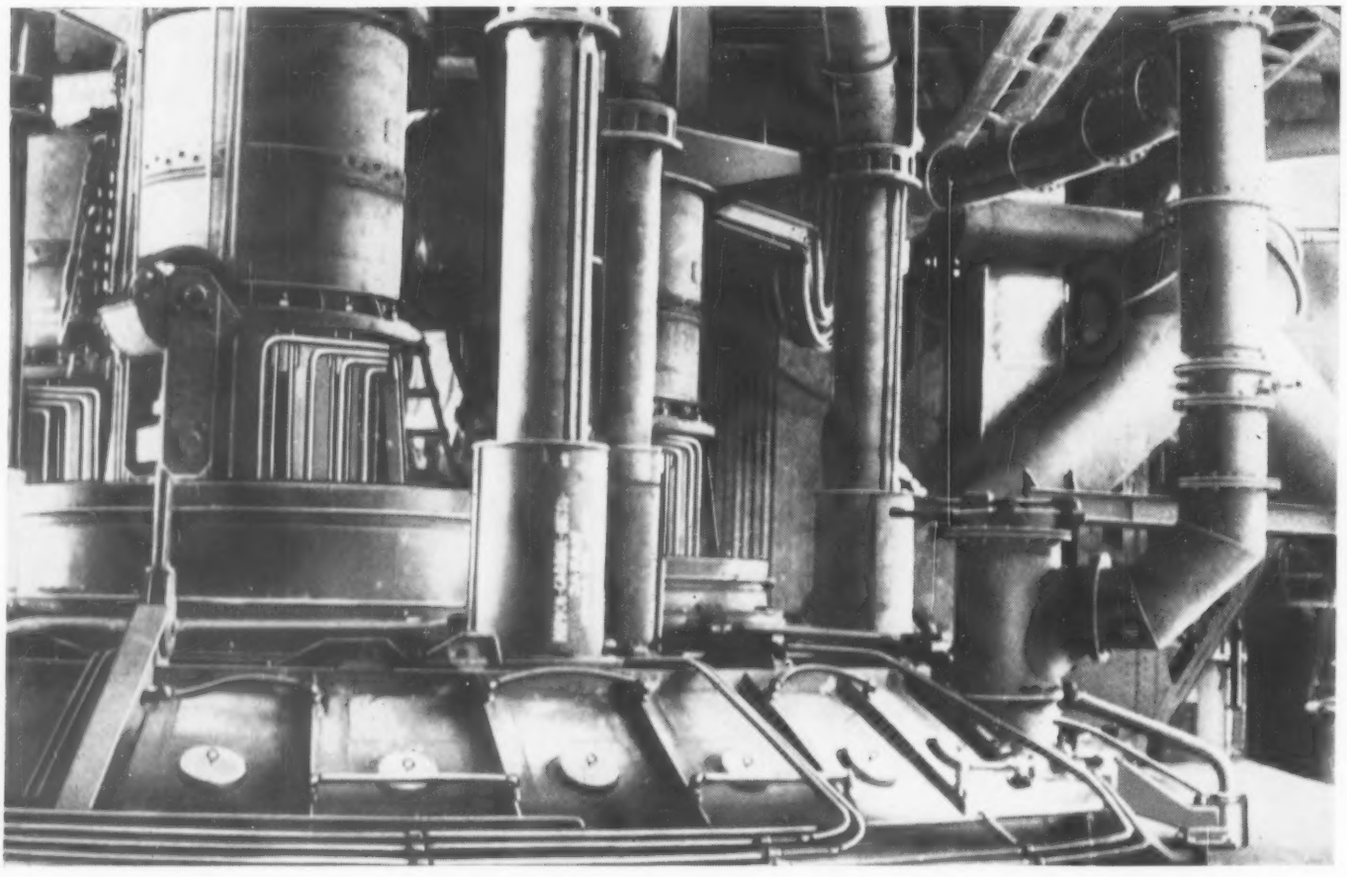

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Mill Gearing As Viewed By A Lubrication Engineer

. . . .it is difficult to apply small gear design techniques to large steel mill equipment . . . .nevertheless, some of the procedures of AGMA and those of Buckingham, intelligently applied, may indicate when failure may be expected . . . . prior to AISE presentation this paper was given before the ASLE convention in Pittsburgh

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GEAR life for periods as long as ten or even twenty years is the hope of every maintenance man in the steel industry. This is not a dream—there are many examples of such performance where the gears in question have been properly lubricated and where ample safety factors have been built into the original design. Furthermore, many of such gears have been lubricated throughout their years of service without the benefit of modern extreme pressure lubricants. It is true that in many instances loads and speeds have been increased over the years and in a great many cases lead naphthenate type lubricants have been substituted for the original oil. On the other hand, despite the imposition of increasing demands, there are numerous units still operating successfully on straight mineral oil. The logical conclusion would seem to be that gear life is more dependent on original design than on choice or type of lubricant.

Even so, problems in steel mill gear operation have harassed the lubrication engineer as well as the lubricant supplier for years. To meet the more severe operating conditions more dependable lubricants of greater durability have been developed. The modern circulating oils of high stability, anti-rust and excellent demulsibility characteristics are typical examples, followed by those fortified with lead naphthenates, generally classified as mild ep (extreme pressure) oils. Simultaneously, various active extreme additives for use in such oils were perfected, i.e., compounds of sulphur, phosphorus, chlorine and fatty oils in various combinations. Introduced as anti-weld and wetting agents, they have become quite popular in the industry. Even solid lubricants have been proposed as additives to reduce scoring and extend gear life. In spite of these advances in the development of lubricants, problems in gear lubrication still haunt the lubrication engineer and hamper his efforts to retard gear wear. These remarks are confined to the major driving units since it is felt that as a whole they are not standing up too well under present day conditions. Possibly this is the price we must pay for increased production. Possibly the economics may in the end justify the sacrifice of such equipment. The more frequent outages and high replacement costs however, require that the matter be reviewed in order to seek a solution to this problem. The present trend of accelerated failures must be arrested.

With this thought in mind, the author has reviewed a cross section of examples of gear units in mill operation with which he is familiar, attempting to analyze their performance in the light of conditions as they were found. One theme predominated. Gear geometry and metallurgy are vitally important in influencing gear life—perhaps more so than the lubricant itself.

GEAR TOOTH ACTION

Gear tooth action involves both rolling and sliding. Friction is a function of their relative amount and the

extent of load. The higher the rate of sliding, as in a worm gear, the greater the frictional heat. A spur gear under the same load would generate less frictional heat. Sliding causes the oil film to be sheared at every point between meshing teeth, excepting at the pitch line where pure rolling takes place. To obviate actual metallic contact, the teeth at this line must be continually separated by a film of oil, presumably a thin film under tremendous load. Pressure-viscosity effects and possibly formation of a squeeze film also may be important factors in keeping tooth surfaces apart. Certainly all the elements necessary for these phenomena are present, perhaps accounting for the success which has been observed with some of the light oil applications.

The fact that a hydrodynamic film actually exists between gear teeth even under very severe conditions is apparently no longer disputable. Equations have even been suggested for calculating the film pressure, assuming perfect geometry. Recently (1)* radioactive gears were run on straight mineral oil as well as ep oils, indicating that up to a specific load, there is no wear with either product. The slightest metal transfer would have shown up in the oil. Obviously, the teeth were kept apart by a hydrodynamic film. Beyond the critical load, metal transfer with both types of lubricants was experienced. With mineral oil, wear was in the form of scoring; with the ep product, wear was slower and in the form of chemical corrosion.

And yet, field practices and service conditions exist that point up the difficulty of blindly following design formula. Careless mounting or bearing wear may lead to misalinement causing excessive loads on gear teeth. Undercutting and interference are also serious geometrical difficulties that should be avoided. Tip relief, by beveling or rounding off of sharp tooth edges, is often done to prevent one tooth from digging into the other.

In a steel mill, there are thousands of gears, large and small. The small ones can be troublesome in isolated cases, but usually most of those that are heavily loaded are well designed and adequately lubricated. When unusual wear does develop in a small unit, one usually finds that poor sealing has permitted the entry of scale and water, or that unexpected loads have been applied beyond the capacity of the unit. Mill table drives are examples of this type. Maintenance of small gears represents a high over-all expense item because of the number, although this is easily handled as a regular item on repair turns. Seldom do these auxiliary drives cause major delay.

MILL DRIVES

The most serious offenders are the mill drives and pinions through which all the horsepower required in the actual rolling of steel is transmitted. This power source is usually a motor designed to withstand considerable overloadings, in many mills, as much as 225 per cent at times. Essentially, this means the torque delivered through the gearing to the mill is considerably more than corresponds to the rated horsepower. Similarly, in mills driven by steam engines, torques are sometimes sufficient to stall them. Very high loads can result from difficult sections, special steels, low rolling temperatures and/or excessive drafts. Naturally, the gearing required to transmit this extra power must be capable of handling these peak loads.

Lest it be assumed high loads are exceptions, it is well to emphasize that many mills are operating virtually continuously close to the top of the overload capacity of the motors, though each individual occurrence may only last for a few seconds at a time. There is nothing inherently wrong with this practice as far as the motor is concerned since it is designed to permit it to function in this manner. The fact must be recognized, however, that the gearing, subject to the same conditions, should also be designed to withstand these higher loads which, though they be for brief periods are of very high frequency.

Incidentally, where flywheels are used, the loads on gear teeth are considerably greater than those indicated on the meters. In effect the difference in the amount of energy given up by the flywheel may be appreciable. Obviously, this is a factor which must be considered in the design and lubrication of the accompanying gear drive.

TYPES OF ROLLING MILLS

Rolling in steel mills is accomplished on both hot and cold stock. Mills which reduce hot steel, usually above 1800 F, are constructed to make relatively sizable drafts (section reduction per pass) at these temperatures.

Bloomers and slabbers are driven by large mill motors up to 7000 hp or more or by huge reciprocating steam engines. Torque is transmitted to the two driving rolls through a 1 to 1 ratio gear drive, better known as mill pinions, and their connecting spindles. A separate motor drives the two verticle rolls on the slabbing mill through suitable line shafting and bevel gears. The mill pinions which drive the horizontal rolls are usually of double helical type with coarse pitches, such as 0.4 to 1.0 diametral pitch. Their pitch diameters give the mill its designation, i.e., a 54-in. blooming mill has pinions with 54-in. pitch diameter. Besides the fact these mill pinions reverse, thereby using both tooth faces, their shock loads are very great and frequent. Breakers trip out on these motors at 225 per cent overload although, while meter readings are repeatedly near this figure, the overloads usually are of momentary duration.

In addition to these typical heavy mills, there are other single-stand units such as plate and heavy structural mills, which employ speed reduction gears as well as mill pinions to transmit power to the mill rolls. Steel is also reversed on these mills except in the 3-high mill. Pinions and drives in these mills are subject to shock and heavy loads just as in the heavier duty mills.

The next classification is the continuous mill. Continuous mills are either driven separately by individual motors, gear reducers and mill pinions, as in hot and cold strip mills, or else they may be driven in multiple units as in rod, bar or billet mills.

In continuous hot strip mills there are ten or eleven stands in sequence having their own gear reducers and pinions. Although the surface speed increases from stand to stand, the load is divided between each stand by predetermined mill settings. Since load is a

* Numbers in parentheses refer to Bibliography at end of paper.

function of draft, steel temperature, steel composition and speed, good judgment and co-ordination are required to obtain the best load conditions for each stand. Ordinarily, roughing stand loads are of a higher order of magnitude than finishing stand loads. Pinions and drives in the latter are subject to moderately heavy loads at high speeds and sustained periods (as the strip elongates), whereas those in the roughing stands must withstand very high impact loads for relatively short periods.

In a cold strip mill, the work rolls are driven by gear reducers (or increasers) and mill pinions, or even by pinions alone without reducers. Gear difficulties in these mills do not result so much from shock loading as they do from a combination of sustained heavy loadings and the dissipation of heat generated during the very high peripheral speeds that are reached.

MILL LUBRICATION

Lubrication technique as applied to mill pinions and drives throughout the steel industry is essentially standard, though the same cannot be said of the lubricant itself. Very wide, and even amazing, variations in viscosity and quality are used on similar applications. Nor can one predict performance by evaluating the lubricant alone; we have experienced too many cases of good results with "poor" lubricants.

As for application methods, nearly all modern pinions and drives make use of an automatic circulating oil system, with sprays directed toward the line of mesh of the gear teeth. This applies to nearly all modern mills, the single stands as well as the continuous mills, some of which have stands several hundred feet apart. Most older mills employed bath circulation, each pinion or drive dipping in a bath of lubricant to serve as a circulating medium. Others designed with open gears are lubricated with tacky compounds, either with or without ep additives. Many plants, where possible, are converting to circulating oil.

There are definite advantages offered by the circulating system, particularly where contamination and heat must be counteracted. Such systems circulate oil to multiple units and return it to the storage tank where it can settle for at least half an hour before being returned to the individual points of lubrication. High speeds and loads generate a great deal of heat and a circulating system equipped with an oil cooler is the best way to keep it under control. Abrasive foreign matter such as mill scale, along with water, can enter pinion housings due to their proximity to the mill. This is removed by the filters or strainers which form part of the reconditioning system, thus insuring that clean oil is returned to all points of lubrication. Their regular inspection must be made, not only to be sure that any such lubricating and reconditioning system is functioning effectually, but also to afford opportunities to look for minute steel particles, almost a certain indication of gear wear.

Generally speaking, the oil should be directed in copious quantities onto the faces of gears as they come into mesh. Usually specially designed nozzles are used for this purpose so that flow patterns from individual nozzles overlap, completely enveloping the teeth. Rates of flow vary widely. The only flow criterion is that the gear be kept cool. Incidentally, there have been several instances of spray applied on the outgoing mesh for high speed operation. In some cases the gear box temperature was reduced, but there was also an instance of increased vibration until oil was restored to the incoming mesh on a rod mill drive.

GEAR DESIGN THEORY

For a better understanding of this subject, a short survey of the literature seems desirable. Many papers are available covering the theoretical aspects of gear lubrication, gear design and gear metallurgy. Unfortunately, steel mill gearing has not been too widely studied. In the past, design theories have been verified only on relatively small gear test stands. This was done, for example, by the ASME Committee headed by E. Buckingham (2), whose work provided means for determining wear criteria for spur and helical gearing. These formulas have been modified to become the basis for much of the AGMA gear design criteria. However, none has received wide acceptance in the design of steel mill gearing. The latter are coming in for special attention at the present time by the AGMA, giving hope that this special problem may be closer to solution (3).

Buckingham's (4, 5) technique recognized the relative importance of tooth geometry, machining accuracy, gear hardness and speed. Constants employed in the equations were obtained empirically from the numerous test runs conducted by members of the committee. Where this approach applies, it is possible to predict the load capacity of a gear—governed by wear, and thereby determine whether the anticipated load will exceed it. To be adequately designed the computed limit load for wear must exceed the dynamic load, which is greater than the tangential tooth load by a factor predominantly influenced by speed, materials and tooth error. This is independent of the type of lubricant used, although it is recognized a lubricant must be present to lubricate and keep the gears cool.

The approach of Buckingham is based on the more fundamental work of Prof. Hertz in 1882 (6). Equations developed by Hertz for determining the compressive shear stresses between two cylinders in loaded contact have been modified and applied to gear teeth. Hertz's stress equation is actually an indicator of resistance to local compression and may be related to pitting type failures. Buckingham's tests however permitted him to include wear-type failure within the scope of his modified formula. Forms of wear other than pitting may be relieved by ep oils if such wear involves surface welding. Failure due to pitting cannot be helped by ep oils. In addition there is a form of wear involving plastic flow of material which also cannot be helped by ep lubricants.

In applying the Hertz equation, it is obviously important to know how many teeth are carrying the load at any time, and at what point on the face of the tooth the worst condition exists. Theoretically, there are two places; (1) at the instant of initial contact where the root of the driving tooth is highly stressed, and (2) at the instant of final recession when the tip of the driving tooth and the root of the driven tooth are highly stressed. If, during either of these instances, the

load is carried completely by a single pair of teeth, then we have the worst possible condition. Buckingham (4) points out, however, that there is less evidence of wear in the dedendum or addendum areas than at or near the pitch line. This, he reasoned was due to bending at the tip, thus transferring the effective load elsewhere on the tooth. Therefore, application of Hertz's equation was made to apply to the pitch line radius of curvature. Furthermore, since a single pair of teeth will carry the load a large percentage of the time, the wear criterion assumes that all the load is carried by one pair. As mentioned, these equations established a critical maximum safe load beyond which excessive wear takes place. These are based on maximum specific compressive stresses of about nearly twice the elastic limit of the weaker material; its degree depending on the susceptibility of the steel to cold working. Thus, limiting load for wear (4, 5):

$$W_w = DfKQ$$

where:

W_w = limit load for wear, lb
D = pinion pitch diam, in.
f = face width, in.
K = load stress factor, $\dfrac{S^2 \sin \phi \left(\dfrac{1}{E_1} + \dfrac{1}{E_2}\right)}{1.40}$
ϕ = pressure angle of gear teeth
E_1, E_2 = modulus of elasticity of materials in pinion and gear, psi
S = maximum specific compressive stress, psi
Q = ratio factor $= \dfrac{2N_2}{(N_1 + N_2)}$
N_2 = number of teeth in gear
N_1 = number of teeth in pinion

In determining W_w one must realize "K" is based on empirical results obtained after numerous test runs on a fatigue testing machine of two cylinders in loaded contact. Essentially, W_w represents the equivalent static tooth load in a pair of gears as that applied between two cylinders with the same radii of curvature and moduli of elasticity as the gears in question, that load corresponding to the safe endurance limit of the cylinders.

Admittedly, use of such data until now has been limited to smaller, more precise gear sets than we are discussing, but we hope to show that we may be justified in their use for the large units.

The equation for "K," the load stress factor, is a modification of the Hertz stress equation for two rolling cylinders in loaded contact.

The formula for the dynamic load (which is compared with the above limiting load for wear) makes allowances for the effect of speed (pitch line velocity), materials, tooth form and expected errors in manufacture. Based on Buckingham's committee work, for spur gears, it is:

$$W_d = W + \frac{0.05V(fC + W)}{0.05V + \sqrt{fC + W}}$$

where:

W_d = dynamic load, lb
W = tangential tooth load, lb $= \dfrac{33{,}000\ hp}{V}$
hp = horsepower transmitted
V = pitch line velocity, fpm
f = face width, in
C = deformation factor, a constant, based on tooth form, precision in manufacture and the moduli of elasticity of the mating materials

Similar equations have been developed for helical and double helical gears, and include the modifications caused by the effects of the helic angle, ψ.

$$W_w = \frac{DfKQ}{\cos^2 \psi}$$

$$W_d = W + \frac{0.05V(fC \cos^2 \psi + W) \cos \psi}{0.05V + \sqrt{fC \cos^2 \psi + W}}$$

where W = tangential load in plane of rotation, lb

There is one more basic design approach to be considered and that is to insure the adequacy of the tooth's beam strength. It is evident that a gear tooth is really a cantilever beam, fixed at one end with a varying load applied progressively from its root to its tip and vice versa. On a helical tooth, the load fluctuates along its length as well as it comes into mesh with the mating tooth. The well known Lewis formula has been successfully used, taking the following form:

$$W_s = Spfy$$

where:

W_s = safe bending load on gear tooth, lbs
S = safe static bending stress (flexural endurance limit), psi
p = circular pitch, in.
f = face width, in.
y = tooth form factor (tables available)

The tooth form factor is based on a structural analysis of a cantilever beam loaded on its extremity.

A stress concentration factor "β" related to the fillet radius at root of tooth is introduced, giving:

$$W = \beta Sfpy$$

It will be observed that the formula considers the entire load to be carried at the top of the tooth. However, due to either elastic deformation or tooth error, the load will very likely come into play lower down toward the middle of the tooth. Depending on the contact ratio, for short periods, one tooth is carrying the entire load.

Helical gear beam strength is calculated similarly although because of the angular contact line, the ends of the teeth are subject to a higher momentary stress at the beginning and ending of the meshing. However, because of elastic deformation, a second pair of teeth almost instantaneously will come into contact helping to share the load. In helical teeth, the tangential load normal, or perpendicular, to their face is greater than the tangential load in the plane or rotation; but the developed length of face width exactly compensates for this increase since it is greater by the same ratio. The beam strength equation is a modification of the Lewis equation:

$$W_s = 0.75 S_t p_n f_a y \cos \psi$$

where

W_s = limiting beam load on teeth, lb, (plane of rotation)
p_n = normal circular pitch = p cos ψ
f_a = active face width, in.
S_t = bending endurance limit of material, psi

ψ = helix angle
y = tooth form factor, determined from virtual or formative number of teeth, N_v.

$$N_v = \frac{N}{\cos^3 \psi}$$

where N = actual number of teeth.

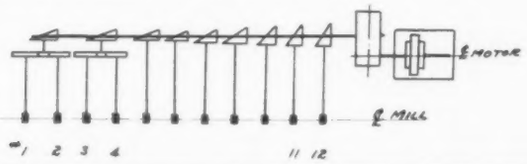
There are other aspects of gearing that have come under the designer's scrutiny, as effect of impact, torsional deflection, tip interference, surface, finish, etc., and each has been recognized and adjusted for in the average application.

Obviously, the simplicity of the Buckingham and Lewis equations make them highly attractive for the design of steel mill gears. But we recognize the constants were all obtained empirically and compiled for gearing different than ours. To collect sufficient data from large steel mill drives for the same purpose is obviously a most difficult job. Buckingham's formula tolerates a maximum error in action of about 0.005 in. For our larger units, this would be too optimistic, so that it becomes clear the formula cannot be applied blindly. Due to the lack of reliable steel mill data, the establishment of appropriate criteria has therefore been held in abeyance.

The prevailing practice has been too often to rely on past experience, to study a previous similar application and hope for the best. Sometimes the results are good; but just as often they are not. We feel in view of the ever-changing, ever-increasing demands placed on existing and new equipment, that this procedure is risky and a more dependable one should be developed and followed.

One conclusion to be drawn from the work of Buckingham is that if the gear materials and geometry are adequate, there should be less pitting, less wear and therefore less need for other than straight oils. From a cost and security viewpoint, this should be an ideal to be sought. A drive that requires an extreme-pressure oil to prevent wear presents an undesirable situation as there is less margin of safety available to accommodate changing conditions that invariably produce even greater loads. Despite this seemingly basic principle, its universal acceptance will never come about until design criteria are agreed upon. Because there is no existing design criterion for our large gearing, we have applied Buckingham's wear and dynamic load formulas and compared their predictions with the actual results. Some of these specific studies follow.

Figure 1 — On this 18-in. continuous billet mill, face length of spurs was increased from 12½ to 18 in.



GEAR DESIGNATION		HARDNESS BHN	FACE IN.	VEL. FPM	H.P. TRANS.	DYNAMIC LOAD #	WEAR CAPACITY #
#1 SPUR	OLD	240/185	12.5	232	225	36,230	56,000
	NEW	212/176	18	232	200	32,280	49,000
#2 SPUR	OLD	240/190	12.5	232	300	47,160	54,600
	NEW	212/180	18	232	270	43,850	46,000
#3 SPUR	OLD	197/203	12.5	364	354	38,450	52,500
	NEW	219/185	18	364	318	31,070	55,500
#11 BEVEL		190/190	12.5	1915	815	39,800	73,400
#12 BEVEL		190/190	12.5	2060	815	40,200	64,000

CASE HISTORIES

1. *Bar mill*—An 18-in. continuous bar mill, having twelve stands and driven by one large motor through a main line shaft, is our first study. In this installation, the main shaft drives the mill stands at right angles to it

Figure 2 — Scoring was evident in the old pinion.

Figure 3 — Spur gear on 18-in. mill.

Figure 4 — No. 2 spur gear on 18-in. mill.

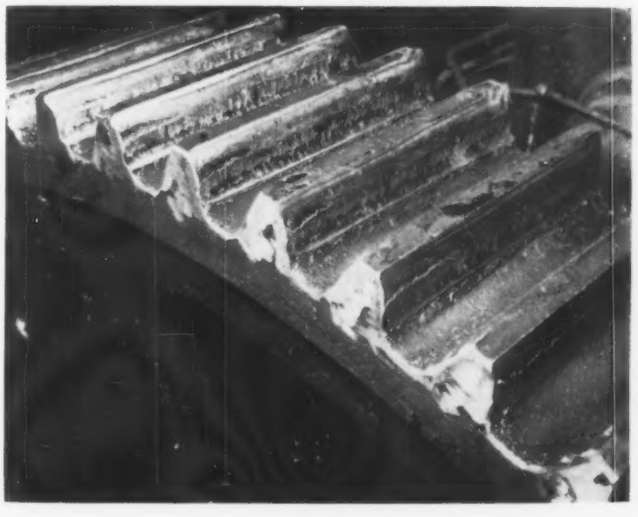


Figure 5 — New spur pinion for No. 3 stand is shown for the 18-in. mill.

Figure 6 — Wear showed up quickly in new gears for 18-in. mill.

through various combinations of bevel gears, cross shafts, reduction spur gears and mill pinions. All the drives on this mill are lubricated from one central system and until recently with a 600-SSU straight mineral oil. The total horsepower on the mill amounts to 5500, which is divided among the twelve stands. It is interesting to examine the wear-load criterion on the old bevel gears driving No. 11 and No. 12 stands, on the old spur gears driving Nos. 1, 2 and 3 stands and the new spur gears driving Nos. 1, 2 and 3 stands and compare them with their actual performance. Figure 1 summarizes the analysis.

In each instance the Buckingham criterion indicated no wear was to be expected. And yet there was a wide margin between the wear and dynamic loads on the old bevel gears as compared with the spur gears. Because the original spur gears were so badly scored and worn away from a combination of poor lubrication and inadequate metallurgy (Figures 2, 3, 4), we conclude first that an ep additive would reduce the scoring, and secondly, the Buckingham criterion was not directly applicable without a higher safety margin. Therefore, a new set was ordered with 18-in. face vs $12^1/_2$-in. and with higher hardness. See Figures 5 and 6.

Unfortunately, evidence of pitting already has begun on these new gears. Actually the spur pinion hardness was reduced from 240 to 212 Brinell simultaneously with an increase in face length from $12^1/_2$ to 18 in. (see Figure 1). However, the advantages of one change were cancelled by the disadvantages of the other, so that the present spur gears and pinions have no greater wear resistance capacity than before. Though tricresyl phosphate has been added to the oil to lessen the scoring, it is evident that these spur gears will eventually fail as did their predecessors.

On the other hand, the bevel gears seem to be unaffected (Figures 7 and 8). At the time of our spur gear change the original bevel gears were kept in the mill. Note that though straight oils have been in use for a long time, apparently the criterion was reliable in this case. To summarize, Buckingham's method of evaluation indicated the bevel gears had a wide margin of safety built into them—while the spur gears had much less. Though the Buckingham criterion indicated no wear should have taken place in either, the fact that the method, as applied to steel mill gearing, did establish the bevel gear rating was higher than the spur and was then borne out in experience, is certainly noteworthy.

It is pertinent to note AGMA's criterion most ap-

Figure 7 — No. 11 bevel gear on 18-in. mill gave satisfactory service.

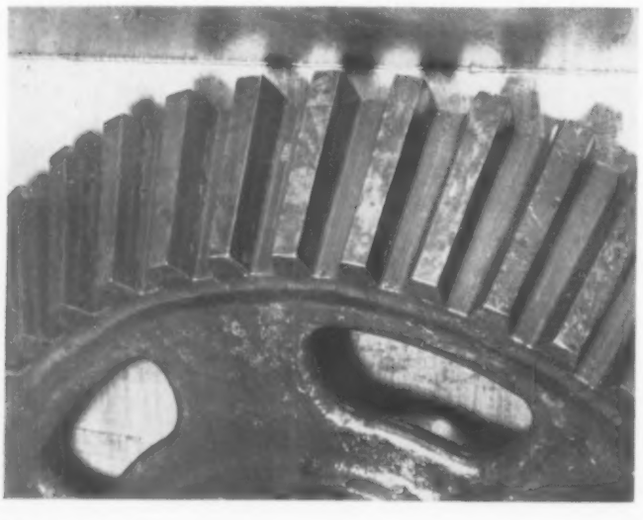
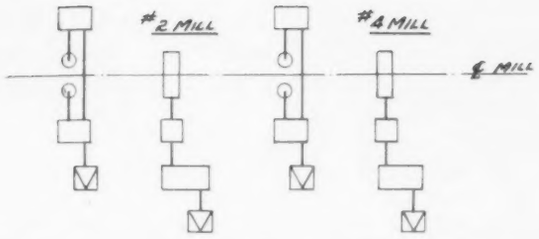


Figure 8 — No. 12 bevel gear on 18-in. mill also indicates that Buckingham's method can be used to evaluate wear.



GEAR DESIGNATION	HARDNESS BHN	FACE	VEL. fpm	H.P. TRANS.	DYNAMIC LOAD	WEAR CAPACITY
#2 MILL PINIONS	280	29½"	89.8	483	180,000#	147,200#
#4 MILL PINIONS	280	29½"	137.8	600	147,441#	147,200#
NEW #2 PINION	280	41½"	89.8	483	180,000#	207,000#

Figure 9 — Layout of 30-in., four-stand billet mill.

plicable to this problem was attempted on the original spur teeth, actually indicating the teeth were underdesigned, unlike the Buckingham criterion. One might ask the relative appropriateness of applying either the AGMA or the Buckingham technique on all steel mill gearing. After this initial study, it was apparent that most steel mill gears fall out of the range of the published AGMA charts and that Buckingham's procedure is more easily adaptable. Therefore, all our subsequent studies were made using the latter. This method may ultimately serve to indicate a solution and perhaps only a minor modification will be necessary to adapt it to steel mill gearing.

2. *Billet mill*—A 30-in. four-stand billet mill was recently installed and almost immediately the pinions on the second and fourth stands began to pit. A well recognized lead naphthenate type ep lubricant had been used from the very beginning, and of course the situation caused alarm. In an effort to track down the trouble, studies of loads were made and photos taken bimonthly for record purposes.

The Table shown in Figure 9 gives some idea of the load conditions.

Note the wide difference in the dynamic and wear load of No. 2 stand, whereas No. 4 stand's wear-load capacity is closer to its dynamic load. Figure 10 shows the pitting condition two years ago on No. 2. Figure 11 is recent. At the beginning there were but a few isolated pits, but after nearly two years, the destruction has progressed much further, even up to the addendum. Figure 12 shows No. 4 stand today. Careful examination will reveal failure here has not progressed quite so far. Table I shows what effect various design changes (realizing the space limitations) might be made to improve the situation.

The greatest *single* improvement can be attained by changing the hardness to 350 Brinell. This would certainly point up the need for improved metallurgy. Heat treating and grinding facilities are claimed to be the limiting factors on pinions of this size. It would appear therefore that some attention should be given to improving these facilities, otherwise the condition indicated by these pinions will be around for a long time.

In this case, the only attempt at correction has been to follow the vendor's subsequent recommendation, that a different and more viscous lubricant be substituted. The figures reveal that pitting has not ceased and ultimate failure by pitting seems a foregone conclusion.

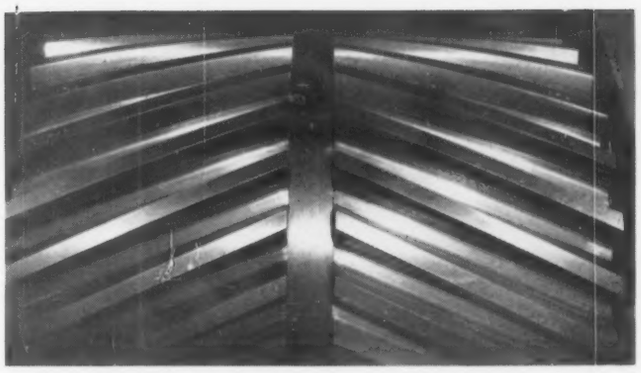


Figure 10 — Pitting started very quickly on No. 2 stand pinion of the 30-in. mill.

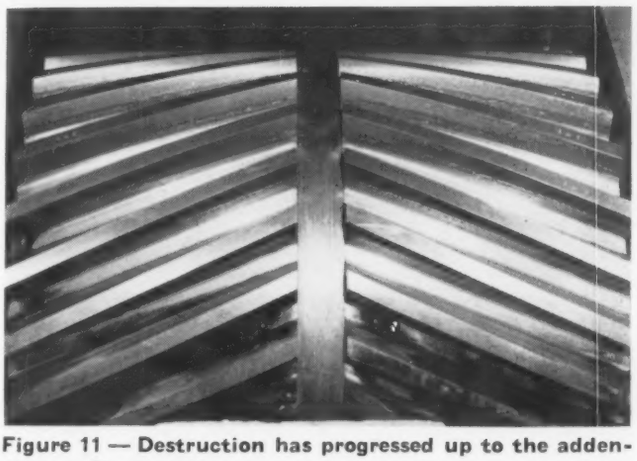


Figure 11 — Destruction has progressed up to the addendum on No. 2 pinion.

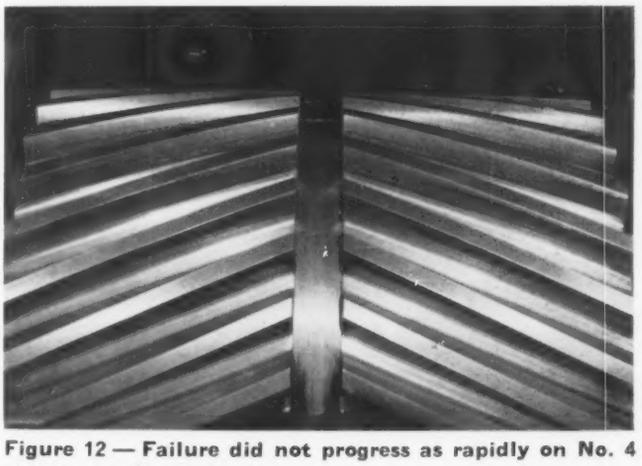


Figure 12 — Failure did not progress as rapidly on No. 4 stand as on No. 2 stand.

In a duplicate installation, the vendor added 12 in. to the face and immediately corrected the difficulty. The limit load for wear was raised by 14 per cent and so far these pinions are in excellent condition. See Figure 13.

This installation seems to point up the fact that cor-

TABLE I
Proposed Changes to Pinions, 30-In. Mill

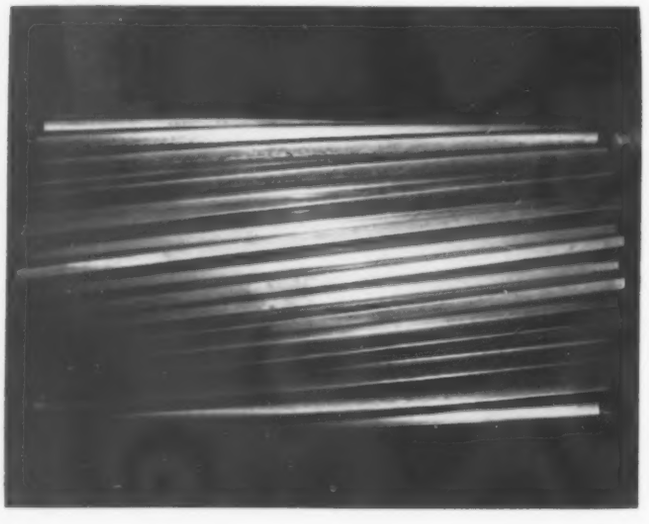
	Modification	Dynamic load, lb	Wear load, lb
1	Change helix angle to 30 degree	179,842	166,000
2	Change to 1¼ diam pitch	180,000	147,200
3	Increase center distance	158,215	168,000
4	Change to 350 Brinell	179,842	268,700
5	Combine 1 and 4	179,842	302,700
6	Combine 3 and 4	158,215	306,100

rection of pitting difficulties cannot be effected by use of ep lubricants. Further, the Buckingham criterion seemed to work as a forecast of the fact that the pinions were inadequately designed. From this point on, in our illustrations, we find the conclusion to be the same—the Buckingham criterion, comparison of the limit load for wear vs the dynamic load, faithfully forecast the condition of the gear teeth regardless of the lubricant used.

Figure 13 — Adding 12 in. to the face corrected pitting on this 30-in. mill.

Figure 14 — Pinions on 42-in. cold strip mill have given no trouble.

Figure 15 — Pinions on 56-in. cold strip mill have given no trouble.



3. *Cold Strip Mill*—Now let us examine cold strip mill pinions.

Taking them in chronological order, the 42-in. tandem mills were erected in 1936–37. In 1941, delivery speed was increased from 1200 to 1800 fpm. All the mill pinions have been in service from the beginning with no ep additives ever used. Figure 14 is typical of all the gears on these stands. The excellent condition of the teeth is apparent. The pinions were case carburized, heat treated and finish ground, and their life seems to be indefinite at this stage, nearly 20 years after installation.

The 56-in. cold tandem sheet mill (our second example) erected in 1947 was originally a 4-stand mill delivering steel at 3000 fpm. Then it was stepped up to nearly 4000 fpm with the addition of a fifth stand—the fourth stand remaining at 3000 fpm.

Figure 15 illustrates the general condition throughout. Even here the teeth look good although only a straight mineral oil has been used.

The third study involves a 66-in. cold sheet mill where trouble developed despite the excellent experience in the two previous mills. Here, despite lapping in place, initial wear soon occurred in the form of metal displacement and some incipient pitting. Immediately

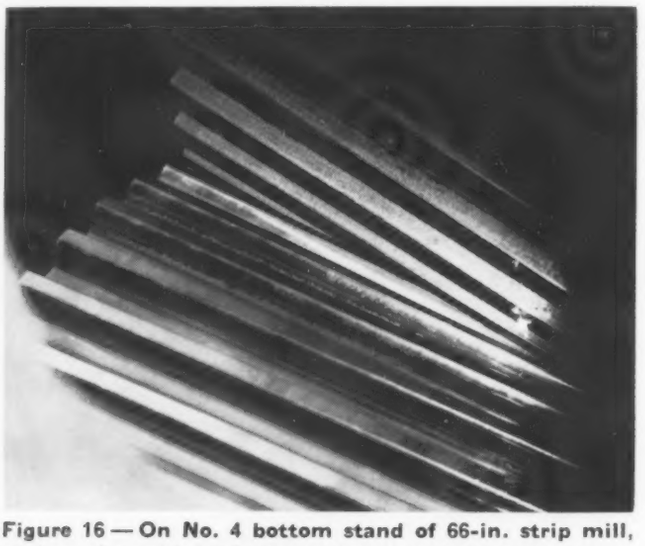


Figure 16 — On No. 4 bottom stand of 66-in. strip mill, pinions showed initial wear and some incipient pitting.

Figure 17 — Use of tricresyl phosphate arrested trouble on No. 4 stand pinion of 66-in. cold strip mill.

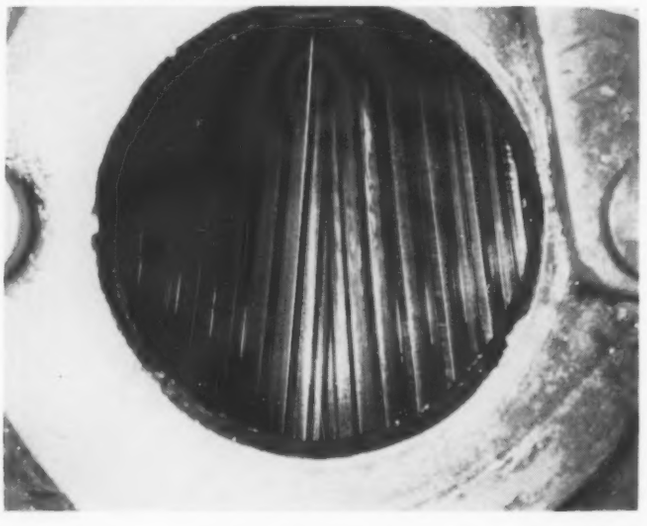


TABLE II
Cold Strip Mill Pinion Study

Mill	Stand No.	Hardness Brinell	Face, In.	Velocity, fpm	Hp transmitted	Dynamic load, lb	Wear capacity, lb
42-In.	2	460	32	520	750	184,500	274,000
	5	460	32	1780	750	53,500	274,000
56-In.	2	311	28	1370	1250	61,600	115,000
	4	311	28	3300	1750	70,500	139,000
66-In.	3 Top	262/277	32	2980	2500	82,600	137,000
	3 Bottom	223/262	32	2980	2500		101,000
	4 Top	255/235	32	3142	2500	83,250	101,800
	4 Bottom	255/235	32	3142	2500		97,500

tricresyl phosphate was added and the scoring diminished, but the pitting continued. Nevertheless, there was some later evidence of work hardening. Figure 16 was taken very shortly after installation. Figure 17 shows the same pinions today. Note the pitting, but these pinions did eventually work-harden, so apparently there is no cause for alarm.

A tabulation of the data, Table II, in all three mills denotes that the 505-Brinell teeth and the 319-Brinell teeth in the 42 and 56-in. mills, respectively, should be satisfactory whereas the 240-Brinell teeth in the 66-in. mill would be somewhat questionable as the margin of difference between the wear limit load for the dynamic load was the smallest of the group.

With this evidence we must conclude the Buckingham criterion certainly forecast the early trend correctly. Providing the limit load for wear is the greater of the two, the larger the margin between the wear and the dynamic loads, the better the performance to be expected. Where work hardening can be expected, this margin will increase and provide greater capacity for longer life.

4. *Hot Strip Mills*—The next illustrations are those of hot strip mill pinions, which have also been lubricated with straight mineral oils. The first, Figure 18, illustrates a failure due to lack of oil after 15 years' service. Observe that the unaffected surfaces of the teeth are in excellent condition after 15 years' service.

Figure 19, in turn, shows a similar pinion from a later installation (9 years' service) also lubricated with a straight mineral oil. Both of these examples show clearly the excellent tooth conditions and are both examples of finishing stand pinions.

Figure 20, shows a 68-in., No. 4 roughing stand pinion with 9 years' service indicating some wear on the addenda.

The worst conditions (see Figure 21) exist on No. 1 and No. 2 roughing stands where shock and impact loads are extremely high. Pitting is a serious factor on these stands and we believe only a tougher, harder gear will withstand the conditions. Table III denotes typical dynamic wear loads on these stands. Note that,

Figure 19 — Pinion on 68-in. mill finishing stand shows adequate wear capacity.

Figure 18 — Lack of lubrication caused failure on this 56-in. hot strip mill pinion.

Figure 20 — Some wear is evident on this 68-in. pinion for No. 4 roughing stand after nine years' service.

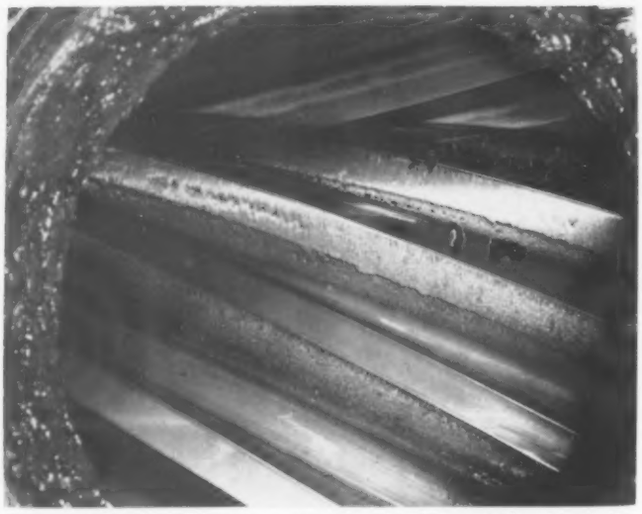


Figure 21 — On hot strip mills, the No. 1 and No. 2 roughing stand pinions must withstand the worst conditions.

Figure 22 — Pinion on 134-in. plate mill has progressive pitting from the start since loaded sides of teeth were not lapped.

Figure 23 — Considerable wear is evident on this 40 by 80-in. reversing slabbing mill pinion after 10 years' service.

where a considerable safety margin has been given these pinions, their performance has been good, otherwise bad.

Table IV, in turn, illustrates a typical rolling schedule per stand on hot strip mills and is indicative of how loads are distributed among the various stands.

5. *Miscellaneous examples*—By just one of those unfortunate circumstances, the manufacturer of a set of plate mill pinions lapped them in his shop on the unloaded side of the teeth. Consequently, the loaded face had tool mark imperfections from the beginning. Figure 22 shows considerable pitting that appears to be progressive, undoubtedly continuing until the gears are reversed. These pinions were lubricated from a central oiling system with a lead naphthenate type oil. Regardless of the oil, or even in this case of the wear capacity of the pinions, poor surfaces may be responsible for early failure.

Figure 23 shows a slabbing reversing mill pinion after ten years of service. There is little pitting, but very considerable wear. The pinions were quite soft and were lubricated for all those years with a 560-SSU straight mineral oil. This set was then replaced by another set of pinions and an ep oil was used. Figure 24 shows a view through an open inspection plate. Though not a very clear picture, it does serve to indicate that even the ep material did not prevent flow of metal, nor did it prevent pitting. Loads on this mill are 7000 hp per pinion or about 5100 lb per in. of face.

A blooming mill set of pinions of 3400 lb per inch of face with eight years of service and transmitted dynamic

TABLE III
Hot Strip Mill Pinion Study

Mill	Stand. No.	Hardness Brinell	Face, in.	Velocity, fpm	Hp transmitted	Dynamic load, lb	Wear capacity, lb
56-In.	1	276	48	190	2550	519,000	324,000
	5	322	48	460	2650	208,000	283,000
68-In.	2	285	48	200	3285	616,000	333,000
	4	285	48	475	4560	332,000	288,000
	10	285	48	1950	3150	106,000	220,000

TABLE IV
Typical Pinion Loads Hot Strip Mills

		Stand. No.										
		1	2	3	4	5	6	7	8	9	10	11
56-In. mill	Motor rated, hp	3,000	3,000	3000	3000	3000	3000	3000	3000	3000	3000	...
	Normal peak, hp	5,100	5,230	5300	6710	5260	4460	4460	4700	4460	2000	...
	Dynamic load per pinion, 1000 lb	519	281	209	262	208	116	95	84	85	64	...
	Lb per in. face per pinion	10,800	5,850	4350	5450	4330	2420	1980	1760	1780	1340	...
68-In. mill	Motor rated hp	2,000	3,500	4500	4500	4500	4000	4000	4000	4000	4000	3500
	Normal peak hp	3,760	6,570	9400	9130	8330	4190	3390	3230	4030	6360	3220
	Dynamic load per pinion, 1000 lb	360	616	468	332	308	212	123	84	85	106	75
	Lb per in. face per pinion	7,600	12,800	9750	6930	6400	4400	2560	1750	1770	2200	1560

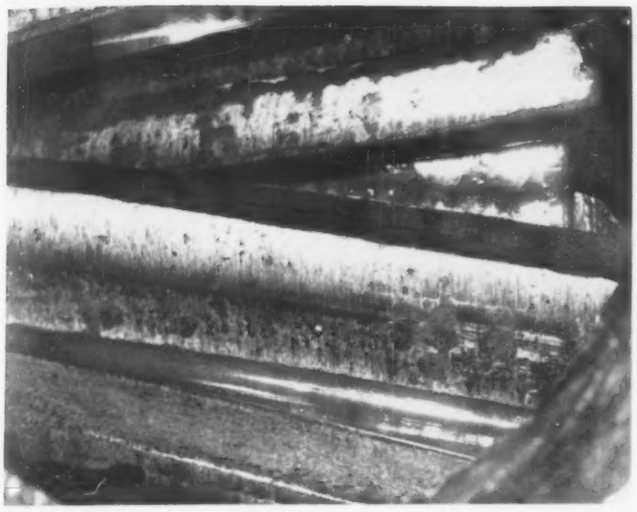


Figure 24 — Loads of 5800 lb per in. of face caused wear on this slabbing mill pinion despite use of extreme pressure lubrication.

load of 213,000 lb is shown in Figure 25. The amazing fact is that these pinions were lubricated with a 300-SSU straight mineral oil for all that time.

Finally, let us review a rod mill in which there are numerous stands in tandem reducing two and three strands simultaneously. Billets starting at $2^1/_2$ x $2^1/_2$ in. are reduced down to small wire. Such a mill has reduction gears and mill pinions as in any conventional mill. In one particular case such a mill had been in operation for 18 years rolling two strands simultaneously, lubricated by 560-SSU straight mineral oil on the entire drive. Despite misgivings of the equipment builder, the gears and pinions did very well with no gear difficulty during that time.

Then the mill was converted into a 3-strand mill and most of the heavy loading concentrated on the first four roughing stands. Trouble began immediately. The spiral bevel roughing stand drives made of 1040 gear material began to pit and then break out from overload. In an effort to improve the situation, a lead naphthenate additive-type oil was quickly substituted but to no avail. The troubles continued just the same. The only real relief was noted when case hardened pinions were placed in service. After that, excellent performance resulted until in time the shock loading superimposed on what may be called gradual chemical wear removed the case, after which deterioration became quite rapid. See Figure 26.

In this case, the solution was neither change of oil nor in gear material, but a new drive altogether, with larger tooth bearing surfaces and a harder gear material. See Figure 27. So the problem was solved by a major operation and not by a mere change of oil. The latter could have retarded welding, but could not check the pitting nor counteract the lack of sufficient beam strength.

While this was going on in the drive, the mill pinions were also failing because of the extra load. The first improvement was to go from a cut gear to a case-hardening and grinding, making use of available grinding equipment. For a while this worked out very well and surfaces were bright and polished. As before, the lead naphthanate ep oil was used. However, after only about a year, the teeth simply crumbled. The hardened case was gone. Another solution was needed. It would have been wonderful if an oil were available to do the job, but this again was a problem where change of oil was not likely to help.

Figure 25 — Observation of this 46-in. blooming mill pinion indicates adequate design for loads up to 3400 lb per in. of face.

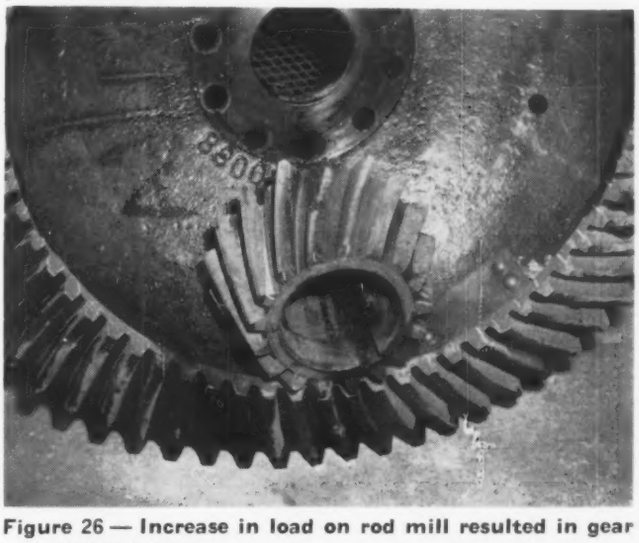


Figure 26 — Increase in load on rod mill resulted in gear and pinion failure.

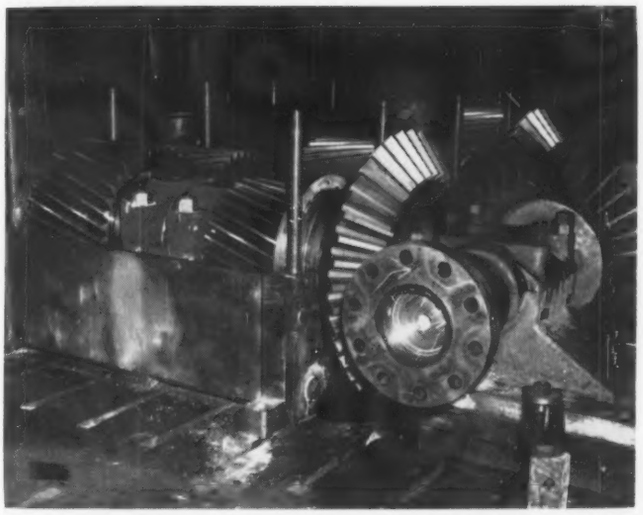


Figure 27 — Straight bevel gears were designed to replace spiral bevel gears on rod mill.

GRINDING PROCEDURE

Just about this time a Swiss method for grinding gear

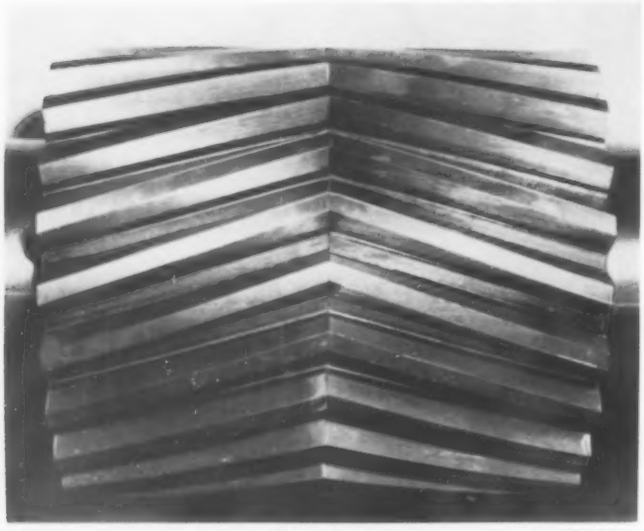


Figure 28 — A Swiss method for grinding gear teeth improves gear life.

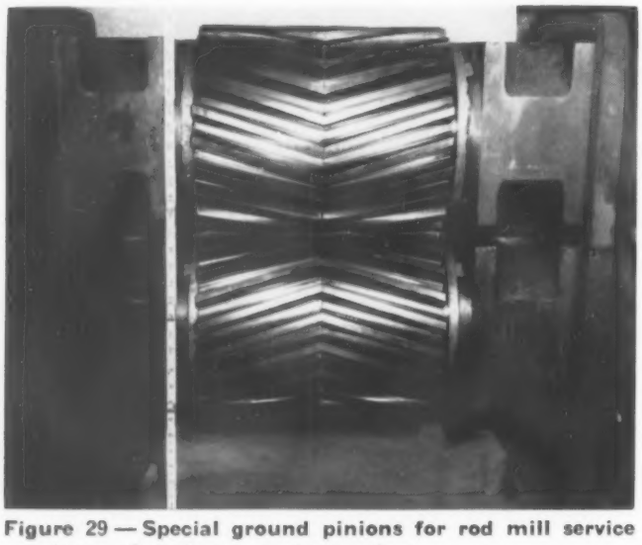


Figure 29 — Special ground pinions for rod mill service are shown after three years' operation.

teeth was under study. The practice of carburizing on large gears had been limited by the availability of grinders capable of grinding their teeth accurately and to a very high degree of smoothness.

Heat treatment always causes some distortion. The harder the surface, the more essential it becomes to provide an accurate tooth form, or else early pitting and breakage are almost certain. For the reason that grinding facilities have been limited, tooth hardness has had to be sacrificed somewhat. Since the Swiss machine and method appeared to be applicable to large steel mill gears, one of the equipment builders co-operated and provided a trial set of pinions case hardened to 426 Brinell. Ground by this method and without a change in lubrication or loading, these pinions enjoyed an increased life of 300 per cent. See Figure 28 before service and Figure 29 after service.

SUMMARY

As a conclusion to this report, we would like to reiterate. All of us recognize a builder's reluctance to attempt to apply small gear design techniques to large steel mill equipment. We can understand that there is no laboratory as effective as the steel mills themselves. However, we have tried to show how at least one aspect of small gear design might actually be useful as a guide if not an accurate prediction of permissible loading of steel mill gearing. We believe we have also demonstrated one further point; lubrication of steel mill gears is only one of the factors affecting a steel mill gear performance—in many cases it is minor.

So a lubrication engineer does his best with the methods at his disposal, but, as has been demonstrated, even the best lubricants are inadequate when gear metallurgy and geometry are below standards for the job at hand.

Oftentimes the wear equation denotes that a specific material should be used, but unfortunately one which cannot be handled because of size limitations in our heat treating and grinding facilities. This problem should be given special consideration by equipment builders.

We know of no lubricant that can substitute for toughness and hardness when these two factors are demanded. Ample anti-wear capacity is the best guarantee against early failure. Perhaps in steel mill gearing Buckingham's wear load limit should be equal to 1.5 the anticipated dynamic load. Where we have had such margins, our gears have lasted longer with minimum wear even though they were lubricated with straight mineral oils.

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Shaft Alinement and What It Means

by Walter T. Saveland, Jr.,
Supervisory Engineer
Renewal Parts and Service
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

. . . . it is extremely important to make sure that equipment is properly alined to minimize maintenance and breakdowns . . . .

A GOODLY portion of the production of this modern age is dependent on the proper functioning of rotating equipment. This is very evident in the iron and steel industry with its enumerable requirements for pump and blower drives, material handling and processing drives, and in power generation and conversion equipment.

Proper alinement of rotating elements will minimize the possibilities of excessive maintenance and actual breakdowns, both of which cause loss of production. Improper alinement can result in excessive bearing loadings, thereby shortening bearing life. Improper alinement can also result in coupling wear or breakage and has been known to result in shaft failures.

Those persons who are responsible for alinement may sometimes speak of alining couplings, or they may speak of alining say a pump to a motor. If they understand the real purpose of this work they realize that what they are actually doing is alining the axes of rotation.

To actually succeed in obtaining satisfactory alinement, there are various related factors that must be considered. These factors must be tempered by knowledge of the types and service of the equipment involved. In most cases, a rigid foundation is required and is an absolute necessity. There are, of course, certain exceptions to this requirement, and when it is known that alinement will not be attained, provision is made for a floating member between the driver and driven shafts.

In many cases, operating temperatures will cause relative movement of parts from observations that are made at room temperature. The alining process must then be directed to obtaining the proper alinement at operating conditions, and in some cases it is necessary to actually check the alinement at operational temperatures.

Another factor that must be considered is axial spacing. This may be directed toward, say in the case of multiple unit motor-generator sets, to obtaining such spacing that individual units can be removed from the line-up without disturbing the remainder of the installation.

Such multiple units with a series of bearings will not have the bearing centers in an absolutely straight line at the conclusion of the alining procedure. If we consider the case of a single, two bearing machine with a shaft extension on either end, we find that the natural sag of the shaft, due to the heavy center loading, will result in the coupling face at each end of the machine tilting slightly from the vertical. This will be the case if we have the two bearings of this machine at the same elevation. If we now take another two bearing machine and aline it to this first machine, we find that it is necessary to raise the bearing centers above the bearing centers of the first machine. The outboard bearing of this second machine will come at the highest elevation. If we add additional machines in a like manner, we find that the elevations of the bearing centers continue to rise. It is necessary, in the case of such multiple unit installations,

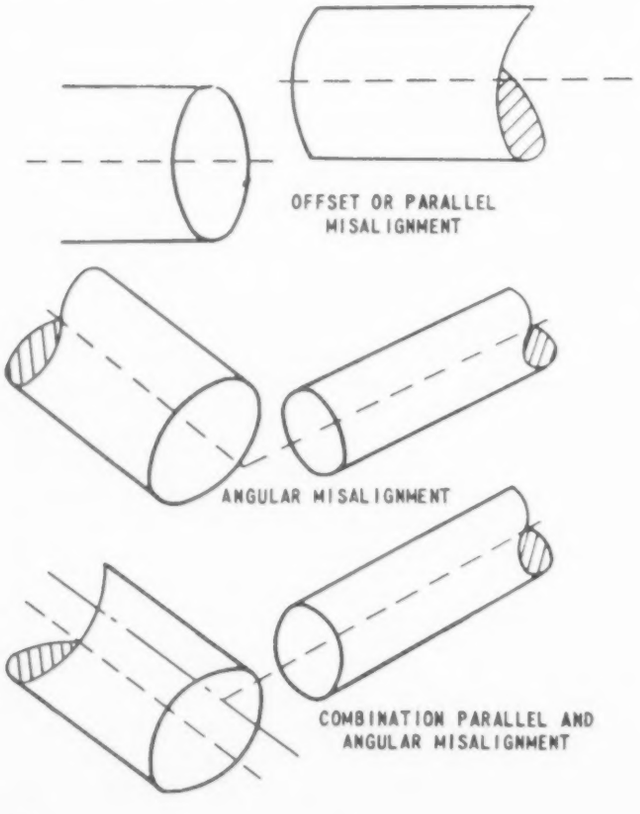
to have one of the heaviest rotating elements near the center of the set on a horizontal plane, and elevate the machines at each end of the set above this plane to enable the coupled up rotating elements to operate without tending to run down hill and impose thrust on the bearings. The case of a two-unit set will require that the two outboard bearings be elevated above the horizontal plane of the center bearing or bearings, to avoid running down hill.

Any motor has a magnetic self-centering force during normal operation and will try to center itself. Coupling action is a factor that can cause thrust on bearing shoulders. In many cases, particularly large high-speed pump drives and the equivalent, it is necessary to limit coupling movement to less than the float in the motor bearings to insure against thrust damaging the motor bearings. If a coupling does generate thrust, either by the two halves pulling together or apart, any thrust imposed on the motor bearings is countered by an equal and opposite thrusting force imposed on bearings of the driven unit. Therefore, any thrusting on motor bearings is also imposed on the bearings of the driven unit.

The largest pieces of equipment, of course, are not factory alined and all of the alinement work must be done at the time of final installation. Smaller units are sometimes furnished assembled on a common base, and may be brought into alinement at the time of installation by careful shimming and supporting of the base, prior to grouting. It is very unusual to find a base structure that is adequately self supporting to the degree that it will not require any alinement check.

In alining one rotating element to another, there are always two components of alinement to be considered.

Figure 1 — The three common types of shaft misalinement normally found in rotating equipment are offset, angular and combination parallel and angular misalinement.



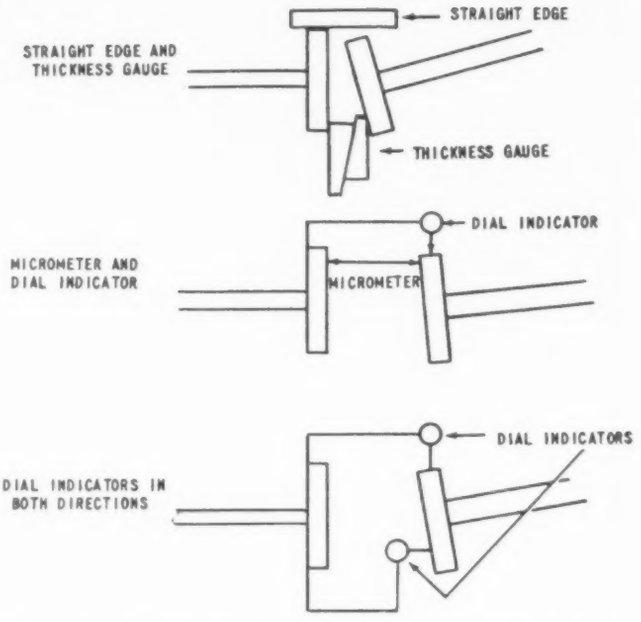


Figure 2 — Sketch shows three effective methods of checking misalinement.

One component is a parallel offset between the two elements and the other component is an angular offset between the two elements. A correction for one of these two components can affect the other component, so in many cases, it is desirable to consider the two components jointly and make a single correction. The actual shifting of one machine relative to the other is time consuming and it is for that reason desirable to minimize the number of such shifts.

The faces of rigid couplings should be perpendicular to the shaft axes and any pilot fit should be concentric with the shaft axis. If this rigid coupling is integral with the shaft and machined simultaneously with the shaft, it must be perpendicular and concentric unless the shaft extension has been bent after machining is completed. If the rigid half coupling has been shrunk onto the shaft extension, it must be faced off after being shrunk on, as the shrinking operation will invariably cause distortion. Trueness of these rigid coupling faces can be checked individually in the machines own bearings or can be checked during the alinement procedure. It should be obvious that any deviations from perpendicular of rigid coupling faces and any offset of pilot fits, will cause shaft bending and runout as the coupling is bolted up tight. There may sometimes be a possibility to cancel out such inaccuracies by rotating one shaft relative to the other to the most advantageous position before coupling, but the net result will usually still be unsatisfactory.

One distinct set of measurements is needed to determine the parallel or offset component of misalinement. Another separate distinct set of measurements is needed to determine the angular misalinement component. Three commonly used methods of obtaining shaft alinement measurements are:

1. A straight edge across coupling diameters and a thickness gage between coupling faces.
2. A dial indicator mounted on one coupling half and indicating on the outside diameter of the

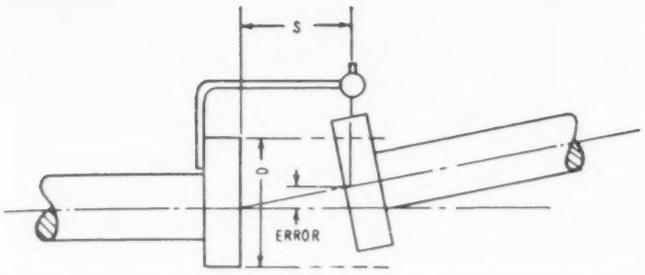


Figure 3 — Angular misalinement can be measured in this setup because it causes a radial runout.

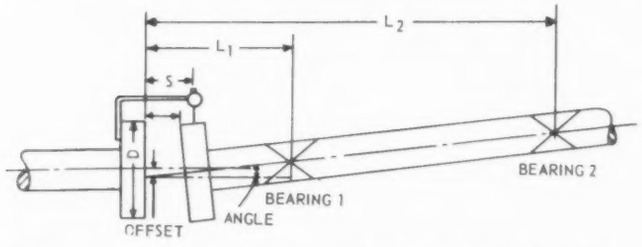


Figure 4 — Sketch shows dimensions needed to determine alinement correction for shaft using misalinement data of Table I.

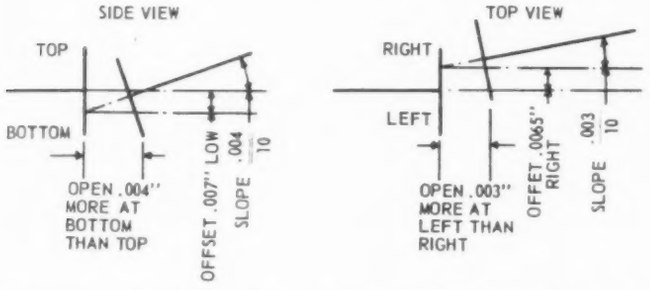


Figure 5 — Sketch shows top and side view of shafts for misalinement data in Table I.

other coupling half and inside micrometers between coupling faces.

3. A dial indicator mounted on one coupling half and indicating on the outside diameter of the other coupling half, and a second dial indicator mounted likewise on the first coupling half and indicating on the face of the second coupling half.

When obtaining measurements, half couplings should be match-marked to assure that the same relationship is maintained between the two shafts while they are being rotated. In Figure 2 the axial spacing of the coupling halves at each position is gaged at four points—top, bottom, right and left. The radial relationship is measured at the same locations on the coupling surfaces.

Upon completing a full revolution of both shafts, it is well to check readings at the starting positions—or better yet, to repeat the full set of measurements to be sure that the readings are consistent. Axial float of the shafts will not affect the result of axial measurements, for the difference will remain unchanged.

Surface inaccuracies will rotate with the shafts and can be cancelled in analysis of the measurements, while misalinement will remain constant in direction. If only one shaft is rotated, there must be positive assurances that the surfaces on the stationary shaft to

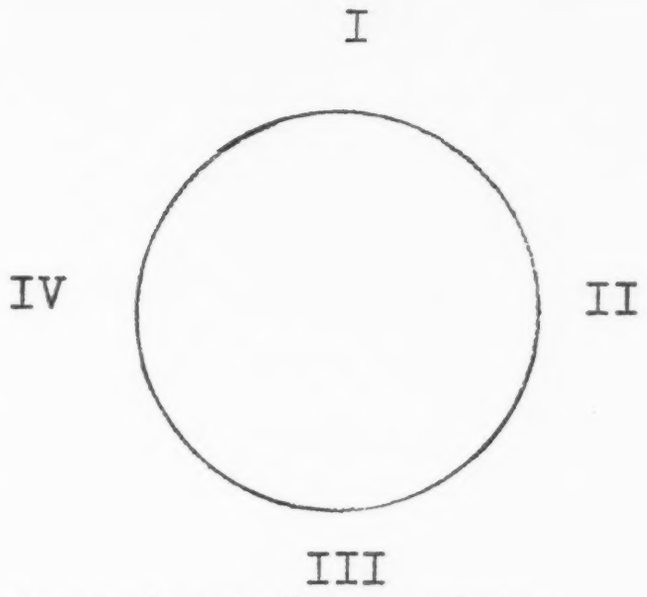


Figure 6 — Key to location of measurements.

which measurements are made are perfectly true. If neither is rotated, it must be assumed optimistically that both are perfectly true.

In figuring the adjustment needed to aline the shafts, one shaft is considered to be fixed with respect to the location of its bearings. The other, the one to the right in Figures 3, 4 and 5, is to be adjusted to correct misalinement. Diameter "D" is the diameter of the circle on which axial measurements are taken. Space "S" is the distance from the face of the coupling on the fixed shaft to the location at which radial measurements are taken on the shaft to be adjusted.

Usually, one set each of axial and radial measurements should be taken at intervals of one quarter turn of the shafts. For rigid couplings, the axial measurements should be taken at four circumferential locations for each position to check accuracy of the coupling faces, i.e., top, bottom, right and left. This method was used in Figure 6.

A minimum of two axial measurements at each position is necessary to check alinement, if the shafts float axially while being rotated. However, this does not provide sufficient data to check the trueness of the coupling and should be used only with flexible couplings. It may be noted that when alining flexible couplings, axial readings are required at I and III, top and bottom, and II and IV, right and left.

If only one axial measurement at each position is taken, the shafts must be held definitely against the bearing shoulders in one constant direction for all readings.

Figure 7 — Two methods can be used for correcting for bracket deflection.

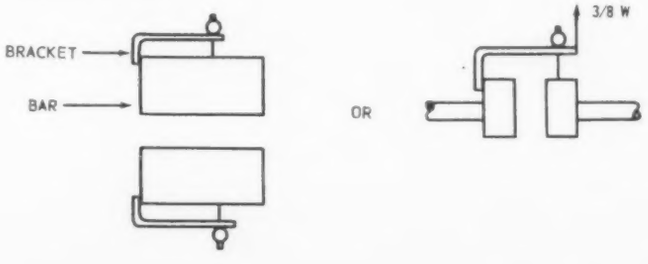


TABLE I
Alinement Data

$D = 10$-in.
$S = 5$-in. $\frac{S}{D} = 0.5$
$L_1 = 15$-in. $\frac{L_1}{D} = 1.5$
$L_2 = 60$-in. $\frac{L_2}{D} = 6.0$

Vertical deflection of Dial Indicator Bracket = 0.002 in.

All Measurements Below Are Multiples of 1/1000 Inch. Whole Inches Dropped.

Angular Alinement Check

		Axial Measurements					Mean Diff. × $\frac{S}{D}$ Correction for Parallel Alinement
	Position	I	II	III	IV	Mean Diff.	
Misalinement Vertical	Top (T)	375	378	370	391	Open at Bottom	
	Bottom (B)	377	382	376	395		
	Diff. (T-B)	−2	−4	−6	−4	−4	−4 × 0.5 = −2
Misalinement Horizontal	Right (R)	375	380	371	390	Open at Left Side	
	Left (L)	378	381	374	395		
	Diff. (R-L)	−3	−1	−3	−5	−3	−3 × 0.5 = −1.5

Parallel (Offset) Alinement Check

	Top	Right	Bottom	Left
Radial measurements	0	13	6	−3
Deflection of indicator bracket	−2		+2	
Corrected runout	−2	13	8	−3

Misalinement Vertical

$$\frac{\text{Top} - \text{Bottom}}{2} = \frac{-2 - 8}{2} = -5$$

Angular Mean Difference × S/D = −2

Resultant Offset −7 (low)

Misalinement Horizontal

$$\frac{\text{Right} - \text{Left}}{2} = \frac{13 - (-3)}{2} = 8$$

Angular Mean Difference × S/D = −1.5

Resultant offset 6.5 (Right)

In the case of rigid coupling with a pilot or spigot fit between coupling halves, which presumably does not permit parallel misalinement, only axial measurements are needed. However, to check the accuracy of the pilot fit, it is advisable to take radial measurements as well.

In making these measurements certain errors must be anticipated. If there is a space between coupling hubs, or if the radial measurement is across a span such that the ratio S/D is 1/10 or more, an appreciable error will be introduced in the radial measurement by the angular misalinement. This is apparent in Figure 3.

A further error can be expected in the deflection of the bracket used for radial measurement with a dial indicator, unless it is very short. The procedure for determining the amount of deflection is shown in Figure 7. For measuring the deflection, the indicator bracket is attached to a bar having many times the flexural rigidity of the bracket. The indicator is set at zero on top of the bar and inverted. The reading in the inverted position will be twice the static deflection of the arm. An alternative method is to weigh the arm and then apply a pull of three-eighths the arm weight at the end of the arm. The deflection due to this pull is about equal to the static deflection of the arm.

TABLE II
Correction of Bearing Positions

Vertical		
Bearing No. 1		
Angular 0.004″ × 1.5 =	0.006″	Lower
Parallel	0.007″	Raise
Net	0.001″	Raise
Bearing No. 2		
Angular 0.004″ × 6 =	0.024″	Lower
Parallel	0.007″	Raise
Net	0.017″	Lower
Horizontal		
Bearing No. 1		
Angular 0.003″ × 1.5 =	0.0045″	Left
Parallel	0.0065″	Left
Net	0.011″	To Left
Bearing No. 2		
Angular 0.003″ × 6 =	0.018″	Left
Parallel	0.0065″	Left
Net	0.0245″	To Left

To demonstrate the value of properly analyzing data obtained in measuring misalinement, a typical problem has been set up. Misalinement of the shaft is illustrated in Figures 4 and 5, measurements and calculations are set down in Tables I and II. In this tabulation of alinement, data measurements and differences are stated as positive when to the top and to the right, negative when to the bottom and to the left.

The mean differences determined from the axial measurements of Table I represent the taper of the coupling gap, or angular misalinement, in units of 0.001 in. across the diameter "D" in the horizontal and vertical directions. In this analysis the runout error of the surfaces is cancelled. The resultant angular misalinement is to be multiplied by factors L_1/D and L_2/D to determine the corrections at the bearings (Table II).

Alinement data in Table I includes the corrections for vertical deflection of the dial indicator bracket and for angular misalinement causing a radial runout in the proportion S/D. The resultant offsets determined from the parallel alinement check are the amounts the shaft to be adjusted is displaced, parallel to the other shaft in the vertical and horizontal directions. These resultant offsets are transferred to Table II and combined with the angular correction values for the net combined correction.

The effect of operational temperatures in changing relative shaft heights from shutdown conditions to normal operating conditions should be considered before actually making a corrective move. This correction can easily be added to the corrections determined in Table II and thereby obtain one single corrective move to be made.

After making the indicated correction and with the units again firmly bolted down, another complete alinement check should be made before doweling, to obtain assurance that no errors have been made, and also just as important, to make sure that the foundation arrangements are solid and unyielding.

Large high-speed drives should be given a "hot check." This will serve to determine whether or not the estimated or recommended relative movements due to temperature have actually occurred. ▲

Light Weight Ladle Crane Trolleys

Allow Larger Open Hearth Heats

Replacement of old ladle crane trolleys by new units made up of weldments and low alloy steels enabled Alan Wood to increase open hearth production by ten tons per heat.

by F. C. Schoen,
Chief Engineer
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AT an AISE convention in Cleveland several years ago, a paper was given on weldments replacing castings, which started a discussion on the possible weight savings if an old crane trolley were replaced with a trolley of welded design. (See "Welded Structures in Cranes and Mill Equipment" by I. W. Evans, 1956 Proceedings AISE, p. 565.)

This was particularly timely for us at Alan Wood as we had gone through most of the usual methods to increase open hearth furnace heat size which could be handled in a single ladle. Our three ladle cranes of 150-ton capacity were originally installed to serve a shop with 12 furnaces of 80-gross ton capacity. Furnace sizes were gradually increased by minor enlargements until we were tapping an average heat of 125 tons. At this time we replaced our riveted type ladles with a lighter weight welded design ladle permitting a further increase in heat size to 130 tons, which with the weight of the ladle gave us a trolley load of 173 tons.

With this load we believed we had reached the practical limit of capacity for the 150-ton trolleys and therefore any further increase in heat size and ladle capacity seemed to indicate new cranes.

Like many of the older open hearth shops, ours was originally built for 50-ton furnaces with runway structures designed for 80-ton ladle cranes. In 1917 the building was lengthened to accommodate installation of three larger furnaces and the 80-ton ladle cranes were replaced with 150-ton cranes of the familiar four girder type. With these additions to the shop, however, no work was done to building foundations, columns or runway girders in the old building, to compensate for the heavier crane loading. An example of this is found in the soil loading of foundations, when the 150-ton cranes were installed on the pit side and a 70-ton hot metal crane was installed on the charging floor side, our footing load exceeded 16,000 lb per sq ft.

During 1950 and 1951 careful studies of runways, columns, foundations and cranes were made and no economically reasonable plan was found for strengthening. One point which was considered when making our analysis, and this may not be a problem for others, was how large did we want our single ladle heats. At that time our order book required many tailor made heats, usually of such a size that a single heat of 130 or 140 tons was ample. This pretty well ruled out large furnaces casting into two ladles. That is the reason for saying no economical reasonable plan could be found. We needed a small increase in capacity but it required a major expenditure. As we have mentioned, we were carrying 173 tons on the trolley, and felt this should not be exceeded; however, our investigations of the ladle crane trolleys and bridges disclosed several interesting facts.

1. Although we found no signs of distress in the trolleys we were loaded to the point that our safety factors were seriously reduced.
2. In examining the bridge, we again found no signs of distress, but, and this was very fortunate, the original design was sufficiently strong so that even with an overloaded trolley we did not exceed normal stresses.

Following the discussion at the Cleveland meeting we decided to examine our ladle crane trolleys, which used heavy castings with riveted and structural members, to see if welded designs could be applied and what weight savings might be obtained.

As the first step a careful estimate was made of the trolley with hooks, spreader, ropes, etc., which established a weight of 145,000 lb.

We then had the following conditions:

Weight of trolley	145,000 lb
Weight of lined ladle	87,000 lb
Weight of metal	260,000 lb
	492,000 lb

To attempt to carry an additional 10 tons of metal it was estimated that some weight increase would be necessary in the ladle proper (due to higher metal line) of possibly 2000 lb, therefore if we were not to increase our load on crane bridge, a new trolley must have weights not exceeding 145,000 less 22,000 or 123,000 lb and must have a capacity of 184 tons.

In addition we believe it would be very desirable to try and get the weight on the bridge of crane back to somewhere near the original design load of trolley weight plus 150 tons.

Accordingly a target figure of 110,000 lb as a proposed trolley weight was established. This would, if reached, permit carrying 10 tons more metal and still reduce the load on the bridge.

While this is slightly ahead of the story, after agreement with the manufacturer on acceptable weights for a new trolley design, we checked the estimated weights by using hydraulic jacks with calibrated gages and found our trolleys actually weighed 152,600 lb.

When this problem was first submitted to the crane builder it was found very easy to obtain the needed capacity, but with a trolley weight of 150,000 lb. This made us wonder if any improvements in design from 1917 on had been made, so Alan Wood worked up a design as shown in Figure 1. It was our contention that many trolleys have a lot of weight in places that is not too useful.

As may be seen we located drive gearing over the equalizer beams and eliminated center bearings on the drum shaft, which saves a bearing support. Each end of the drum shaft is driven, which reduced size of drum shaft since torsional effects are minimized.

An examination of many trolleys will show heavy end frames, heavy ties between end frames, etc., when actually the drum bearings are on end frames and drive machinery does not need some of the massive supports that are used.

The skeleton design as shown in Figure 1 was estimated to weigh only 104,000 lb but it was certainly not conventional for a ladle crane.

A design shown in Figure 2 was counterproposed by the crane builder but again the weights did not meet our conditions.

The design as shown uses more shafting than the first proposal, and a weight saving was attempted by use of the hollow drum shaft. The possible saving in weight of drum shaft is offset due to drive on one end only and the consequent large diameter required due to torsion.

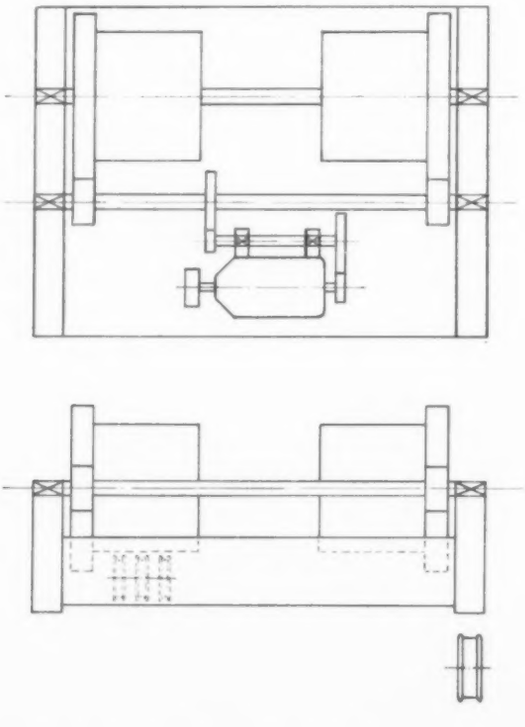
After a number of discussions the design shown in Figure 3 was developed. This design returned to four bearings for the drums. A major change was springing the equalizers and supports between the box section side frames—thus lightening the entire trolley frame. It will be shown later that these inside bearings are carried on 37½-lb, 8-in. I-beams. The weight was still high, but it looked very promising and finally by substitution of low nickel alloys and careful design of load carrying sections for greatest economy, we had a trolley with an estimated weight of 113,000 lb and as finally built and installed 115,000 lb.

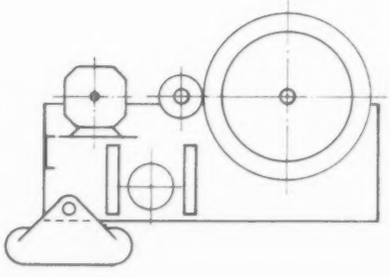
Figure 4 of half sections of old and new trolley framing shows main sections, neglecting clip angles, angle bracing, etc., of a new larger capacity trolley with a frame which weighs 3800 lb less than the old.

Figure 5 shows half sections of old and new hoist shafting, gearing and drums, indicating the major differences in weight. The weights shown here do not include savings in cast bearing boxes, sleeve bearings, etc., when replaced with anti-friction bearings.

Figures 4 and 5 indicate where major savings in weight were made, but they also indicate layouts which are not the usual forms found in ladle trolleys. Considerable discussion arose in the design stage as to the effect of drums, and sheaves with their axis parallel to the bridge motion. Since installation of these trolleys however, we have found no problems with this sheave

Figure 1 — This unconventional trolley design minimized trolley weight.





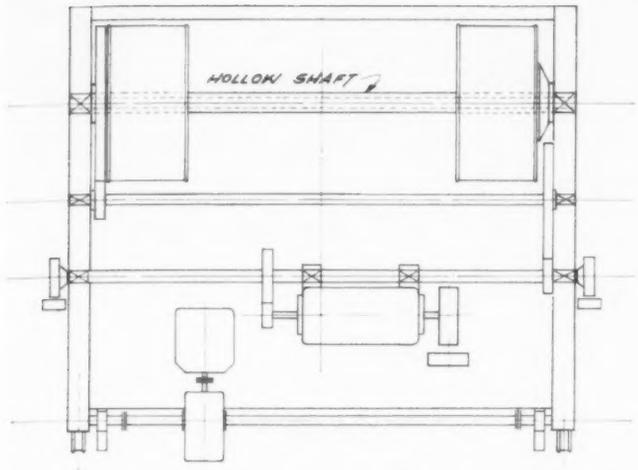


Figure 2 — Another weight saving trolley design involved the use of a hollow shaft.

and rope arrangement that are different than the conventional arrangement.

Another somewhat uncommon design point is the single motor hoist. We were satisfied to use the single motor because one of our cranes had always been single motor and failures, or breakdowns, on this trolley had never been any different than the trolleys with twin drives. An influencing factor of course was weight and we found that a single 614-frame motor had sufficient horsepower to give us a hoisting speed of 8.7 fpm, only 1.3 fpm less than on our old trolleys.

Another weight saving which indicates the difference between the old cast and present welded design is in the four 2-wheel trolley trucks. These bare trucks, with bearing caps, weighed 8500 lb while the new trucks weigh 4210 lb.

Other savings were also made in the trolley drives by the use of two motors and elimination of cross shafting.

We have, from the start of this study, always been curious as to the reason the separator of the hook beam has to be so massive—especially if the hooks were anywhere nearly in line with the centers of the sheaves. The new design (Figure 6) indicates some weight saving in this section, but we believe the large proportions as shown could safely be further reduced in size and weight.

One example may serve to indicate the fact that although we wanted to obtain minimum weights, consideration was given to maintenance.

In the design of main hoist worms, we used double enveloping gearing but we did not accept a design which would have made the gear case and bearing supports an integral part of the trolley framing. It added weight but nevertheless we were of the opinion that a complete gear unit, which could be removed from the crane and shop fitted, was preferable to trying to field fit such gearing on top of a ladle crane.

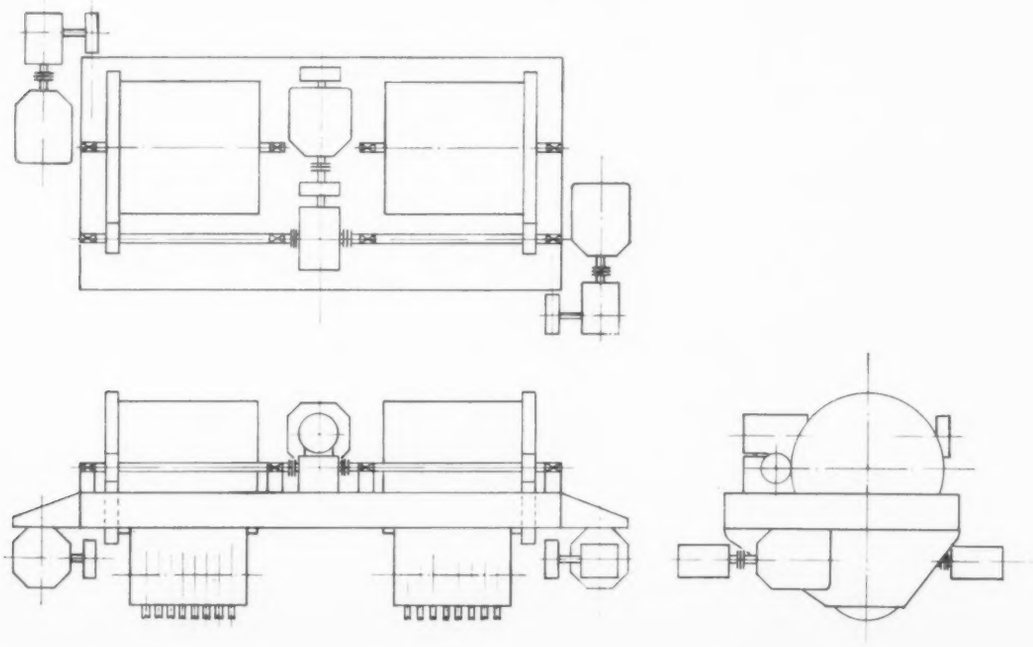
One point should be emphasized, throughout the entire design, even though it is not the usual form of ladle trolley, the AISE Standard No. 6 on cranes was followed insofar as allowable stresses were concerned. It is also likely that additional weight savings may have been realized had we gone to higher alloy, instead of the low nickel steels used; however, it was felt the additional savings would not warrant the additional costs involved.

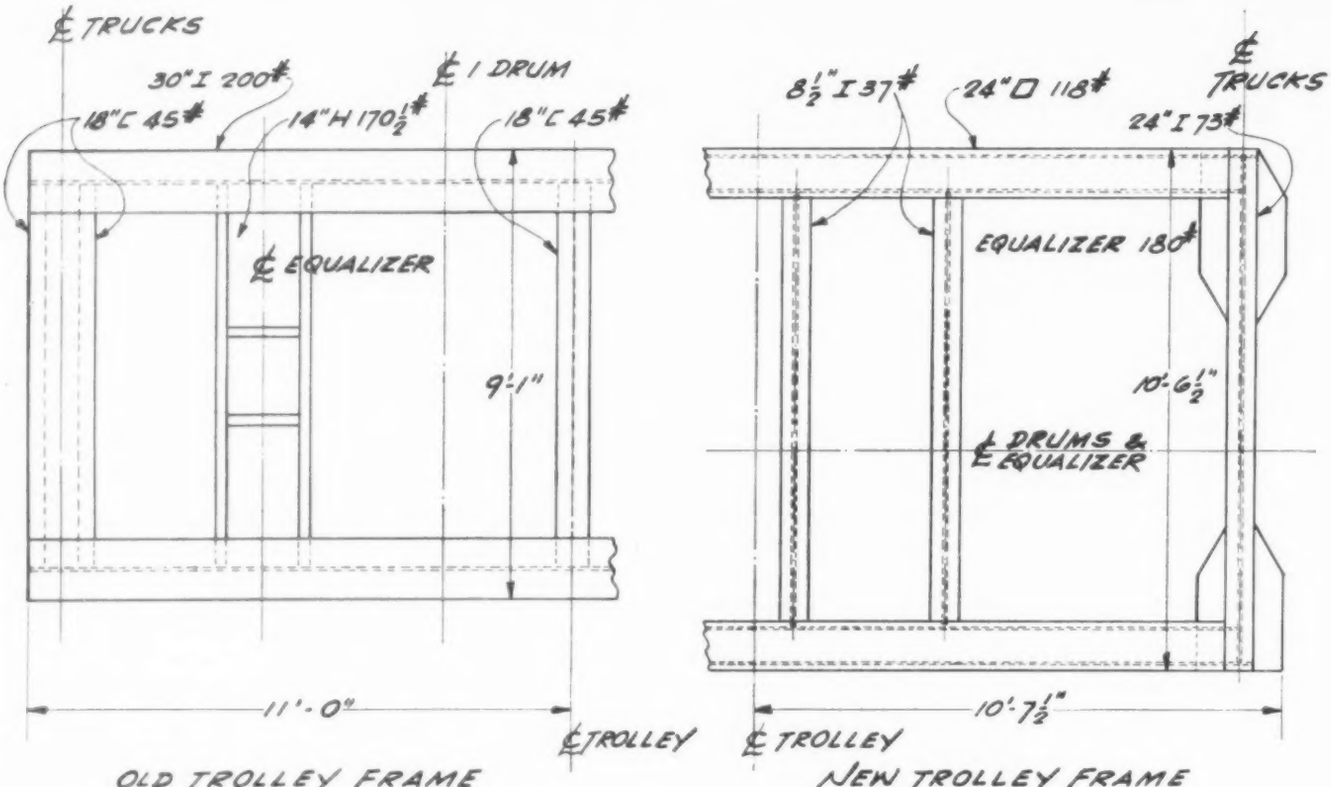
Shortly after the final design of the 183½-ton trolley had been approved, the question was asked: If this weight could be saved on a trolley, would a welded design of bridge permit further weight reductions? If bridge weights could be reduced, should we therefore build into the trolley design the necessary features which would permit a future increase to 200-ton capacity?

An investigation of this feature indicated that the trolley weight would be increased by possibly another 6000 to 10,000 lb due to additional ropes, sheaves, increases in drum shafts, bearings, etc.

This would have meant, for an increase to 200-ton capacity from the 183½-ton, that we would have to save twice the 20-ton increase for metal and heavier trolley, or at least 40 tons of bridge weight due to the fact that we did not want to increase our load on runways and columns.

Figure 3 — Final ladle trolley design used has four bearings for the drums.





OLD TROLLEY FRAME

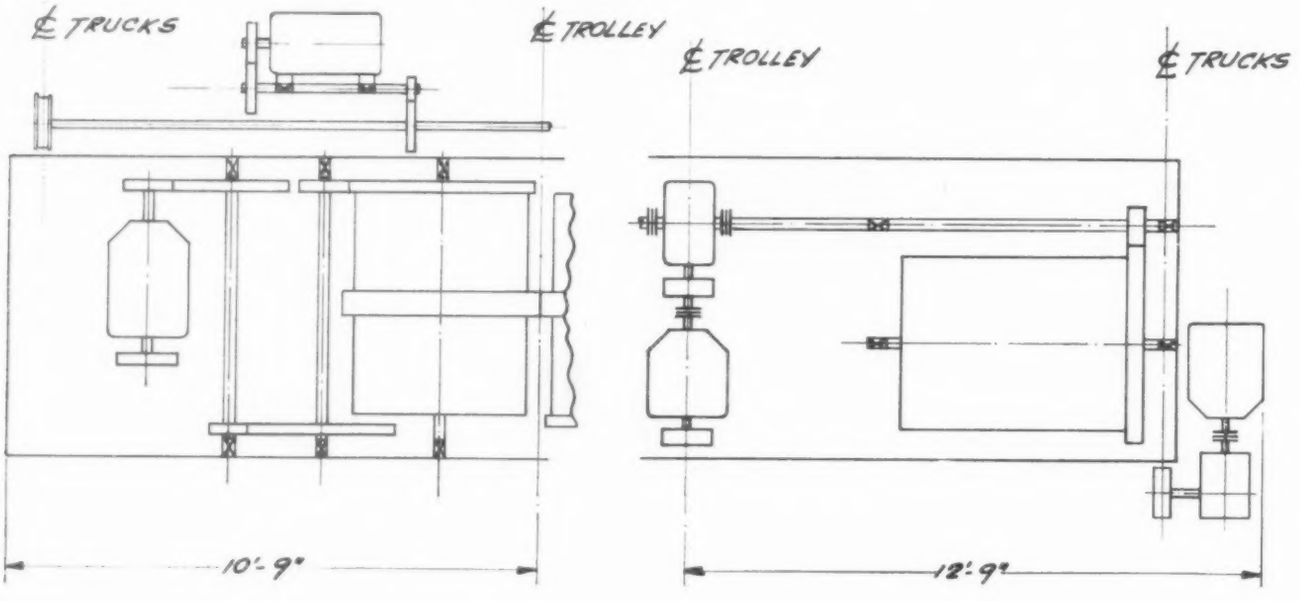
SIDE FRAMES	8,800#
END FRAMES	1,620
CROSS TIES	810
EQUALIZER	3,600
TOTAL WGT	14,830#

NEW TROLLEY FRAME

	5,015#
	1,533
	1,400
	3,000
	10,948# TOTAL WGT

Figure 4 — Sketch compares weights of old and new trolley frames.

Figure 5 — Sketch illustrates weight savings of complete trolley.



DRUMS	23,400#
SHAFTS & GEARING	16,600
END TRUCKS	8,500
TROLLEY DRIVE & M'TR	10,000
HOIST MOTORS	6,800

FINISHED WEIGHT OF TROLLEY - 152,132#
(INCL. CABLES, SPREADER, HOOKS, etc)

DRUMS	20,000#
SHAFTS & GEARING	8,000
END TRUCKS	4,200
TROLLEY DRIVE & M'TR	4,600
HOIST MOTOR	8,200

FINISHED WEIGHT OF TROLLEY - 115,000#
(INCL. CABLES, SPREADER, HOOKS, etc)

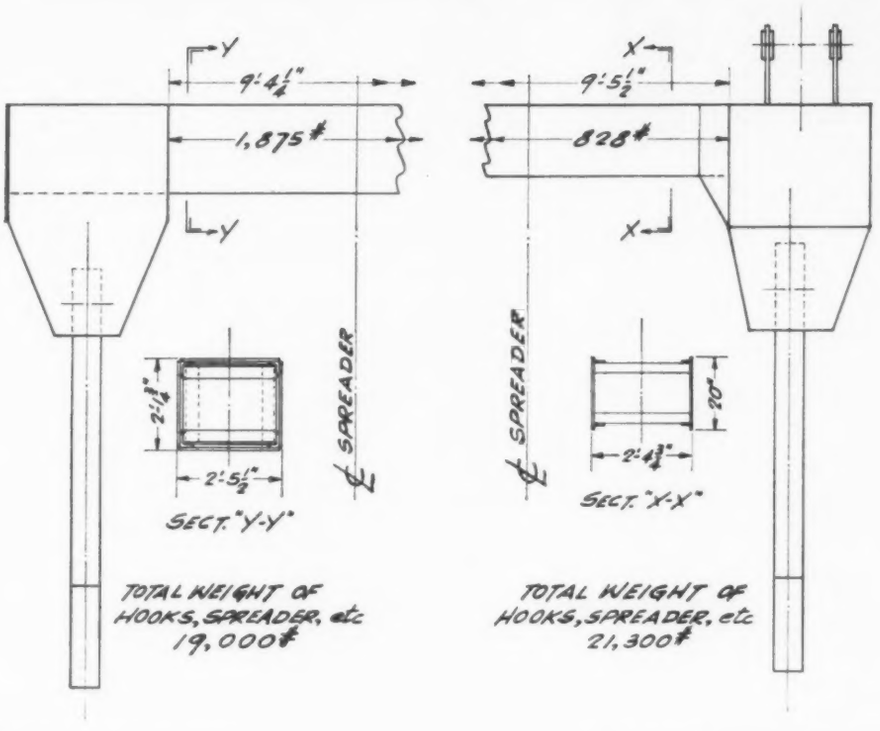


Figure 6 — It is believed that weight savings can be made in the separator for the hook beam.

150 TON SPREADER & HOOK

Without going into all of the details, we soon found that the substantial weight savings possible in a trolley were not as readily available on a crane bridge, the reason being that the percentage of castings, gearing, etc., to total weight is less for a bridge than a trolley.

Our next problem was to see if the expenditure required for the new trolleys could be justified. For this we used a modified form of the Machinery and Allied Products Institute (called MAPI) calculations.

The following are the major factors which were considered when working up a justification for the expenditure.

1. Operating rate—assumed 71 per cent	
Representing seven furnaces or 100 per cent operation	20 per cent of time
And an average of 4.5 furnaces or 64 per cent operation	80 per cent of time
2. Estimated cost	$400,000
3. Property tax and insurance—on new trolleys	$2,000
Due to depreciation nothing used for old trolleys	
4. Maintenance savings	
Yearly average for three cranes for five years	$10,192
Proposed equipment	
Main trolley—Hoist and controls represent approximately 50 per cent of maintenance which, due to modernization, should require approximately 50 per cent of present maintenance.	
50 per cent of 10,192 + 25 per cent of 10,192 =	$7,644

183½ TON SPREADER & HOOK

5. Power consumption existing equipment per year	$7,155
Proposed equipment	
Based on fact that 85 per cent of moves are made with crane unloaded and light weight of crane is reduced by 15 tons which is approximately 2.3 per cent of total weight, we have 97.7 per cent x 85 per cent x 7155 + 15 per cent x 7155 =	$7,011
6. Other	
Saving on 7-furnace operations on account of increased tonnage 20 per cent of time	36,516
Savings accruing due to processing the additional tonnage and profit	62,226
Saving on an average of 4.5 furnaces operating 80 per cent of the time and the increased tonnage	74,607
Total savings (item 6)	$173,349
It should also be noted that if we had used a 7-furnace operation 100 per cent of the time the above figure would be approximately	$425,000

Using the figures and facts just mentioned, we have the following equipment analysis (*Note*, we are showing for purposes of this paper only the factors mentioned, the full MAPI analysis uses many more which did not apply for these trolleys).

Figure 7 — Old trolley is shown upon removal from crane.

CAPITAL EQUIPMENT REPLACEMENT ANALYSIS

1.	Subject of analysis—Light weight ladle crane trolleys	
2.	Operating rate assumed—71 per cent	
	Proposed equipment	*Existing equipment*
3.	Description — Replace main trolleys and control	Ladle cranes 1, 2, 3
4.	Primary service life—25 years	Purchased 1917—Life to date, 38 years
5.	Terminal salvage value (X), 5000	Disposal — Scrap — Value $4500
6.	Estimated cost installed (Y), 400,000	Installation cost, $155,550
7.	Terminal salvage factor X Y, 1.0 per cent	

OPERATING COSTS

	Proposed equipment	*Existing equipment*
Power consumption	$ 7,011	$ 7,155
Property tax and insurance ½ of 1 per cent	2,000	...
Normal maintenance	7,444	10,192
Other	...	173,349
Totals	$16,455	$190,696
		16,455
Next year's variance in operating cost		$174,241
Resale, salvage or conversion value of existing equipment, Return on $4500 x 6 per cent		270
Total		$174,511
Depreciation, loss of efficiency, etc., from MAPI tables, 5.6 per cent + interest 6 per cent = 11.6 per cent x 400,000		46,400
First years gain		$128,111

$$\frac{\text{First years gain } 128{,}111}{\text{Installed cost } 400{,}000} = 32.0 \text{ per cent}$$

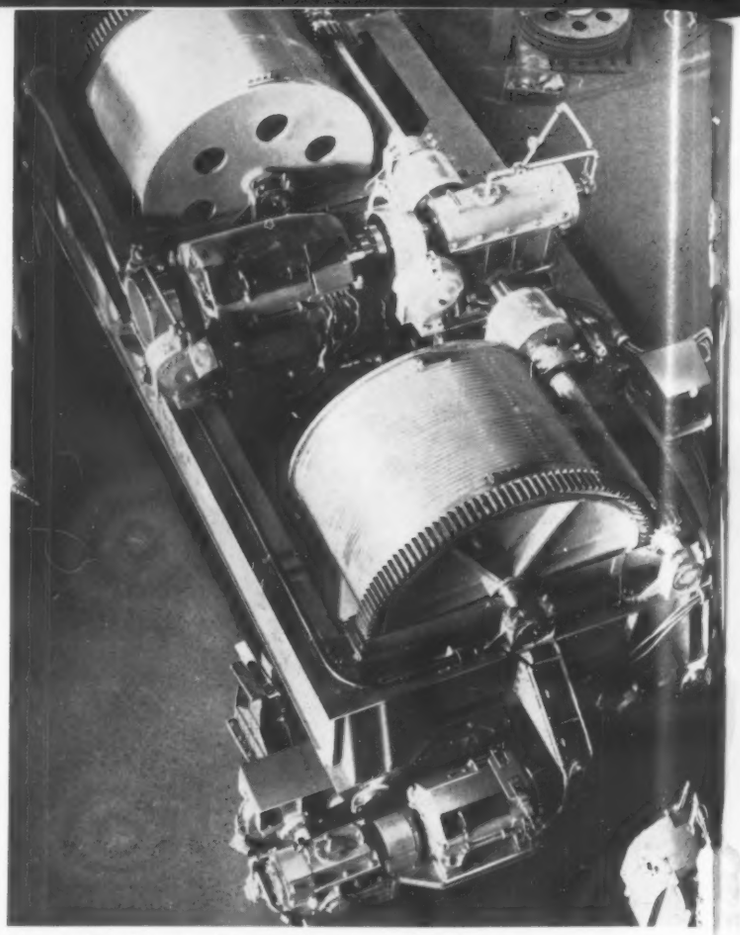


Figure 8 — New trolley used but one hoist motor.

The savings on this basis for the first year amount to 32 per cent or the installed cost which, by the way, included all new controls for trolleys and a sizable amount for mechanical and electrical spare parts.

With these savings for an increase of 10 tons per heat, but a minimum estimated cost for larger ladles, furnace changes and new crane bridges of $1,500,000—with a return of less than 10 per cent—one can see why no serious effort was put on trying to develop light weight bridges for the ladle cranes.

Figure 9 — Old truck was of massive riveted construction.

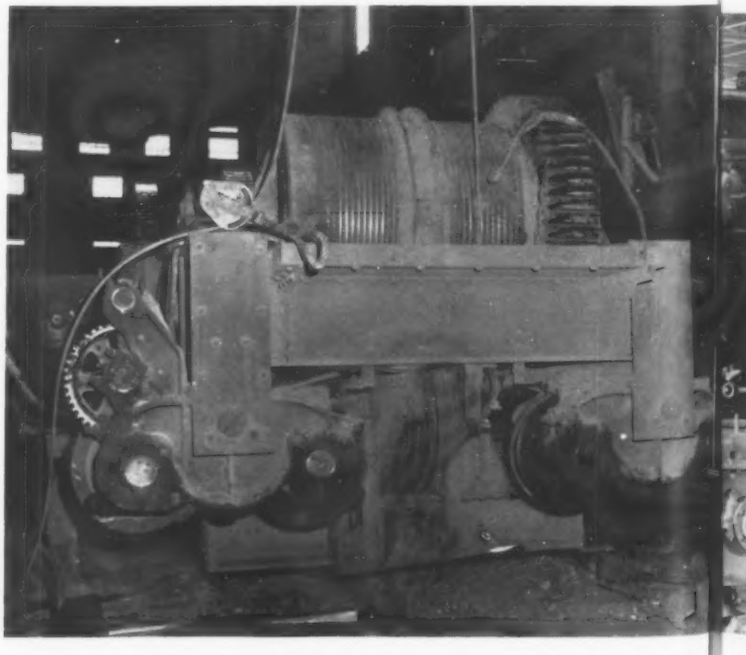


Figure 7 shows the old trolley—after taking it off the crane. Figure 8 shows the new trolley. Figure 9 shows an old truck which contrasts with the new design trolley truck and drive in Figure 10. Figure 11 compares the old trolley drive with Figure 12, the new trolley drive.

In summary we find that our original ladle crane trolleys, which were assemblies of castings, structural members and normal grade plate, when replaced with new trolleys assembled from weldments and low alloy steels, enabled us to increase our open hearth production by 10 tons per heat or 7.6 per cent. We have realized savings during the first year, due to the production increase, amounting to 32 per cent of our investment. We have ladle cranes with modern, low maintenance cost main trolleys weighing 115,000 lb, only 5000 lb more than the original target figure for a new design. Finally we are carrying heavier metal loads on our ladle cranes with lower stresses on bridges and runways than we have had for years.

Discussion

presented by

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ROBERT RICE, Manager, Crane Dept.,
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R. TIETIG, JR., Principal Engineer,
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Henry J. Kaiser Co., Oakland, Calif.

C. F. Simmers: Mr. Schoen is to be congratulated on his fine paper. It is so complete down to the most precise detail that little room remains for comment. However, we wish to state that considerable engineering effort went into the final design of these light weight ladle trolleys in order to get the finished weight within the required limits. The material used in the trolley

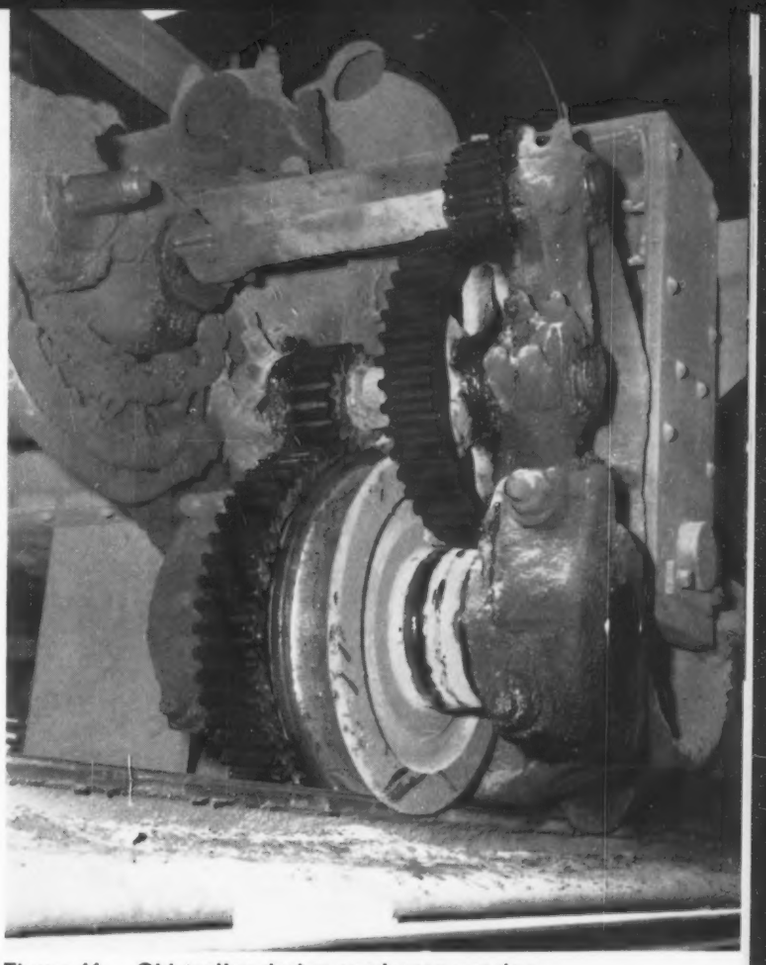


Figure 11 — Old trolley design used open gearing.

frame and hooks is the high tensile, low alloy steel having a minimum yield of 50,000 psi. Welding of this alloy steel did not require any particular preparation. All welded parts were stress relieved.

Relative to the comments concerning the low stresses and massiveness of the spreader beam between the hook and sheave centers, we would like to point out that, over a period of time, serious deterioration occurs in the spreader due to heat and other factors.

Figure 10 — Weldments helped cut the weight of the new truck.

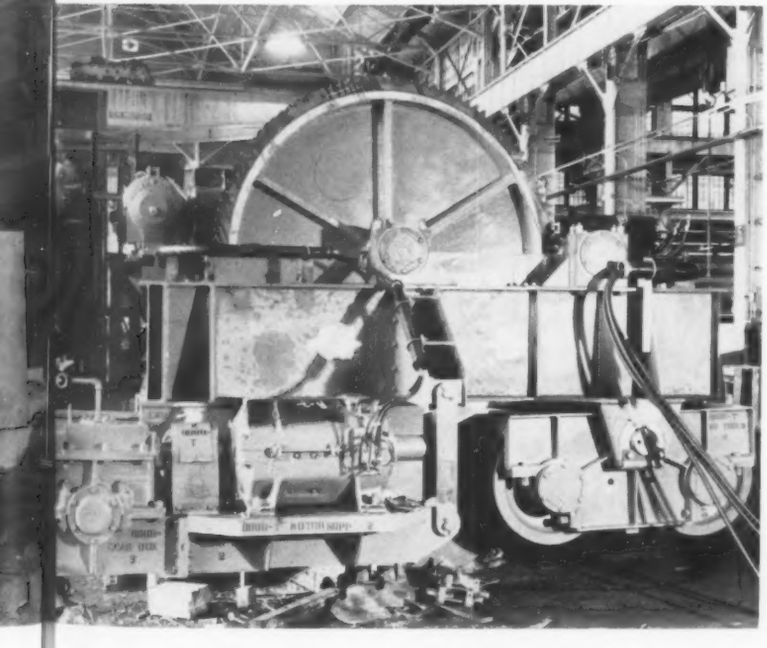
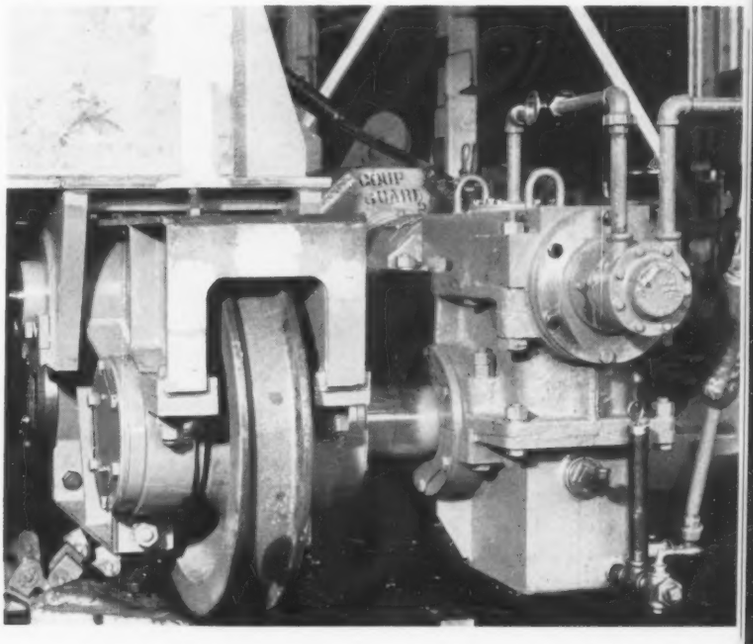


Figure 12 — New trolley design features modern practices in gearing.



On this particular spreader beam, the section over the ladle is composed of two web plates, 20 in. deep x ⅜ in. thick. The webs are separated by 28-in. long diaphragms and have flanges welded to top and bottom, 3 in. wide x ¾ in. thick. The stress in bending is uniform from sheave block to sheave block and is very low. However, due to the constant exposure to heat and fumes, we were quite concerned in considering using webs under ⅜ in. thick.

We would like to point out that each trolley is driven by two 33-hp, d-c series-wound motors, frame 606, wired in series and connected to opposite corner wheels through worm gear drives having a ratio of 23 to 1.

Consideration was given to the use of smaller motors wired in parallel, which would require a ratio in a worm gear of 75 to 1 in order to obtain the specified surface speed of the trolley. This ratio was considered too high for good trolley drive practice and would have required a larger worm gear set. It was found upon investigation that the weight of the larger worm gear set plus its housing would more than offset the weight of the larger motors.

Over the past few years, we have increased the capacity of quite a number of ladle cranes by increasing the parts of rope, reinforcing the trolley frames, reinforcing bridge girders, providing new alloy steel ladle hooks, etc. It was not necessary in any of these cranes to replace the trolleys, as was done at Alan Wood Steel Co., because the small increase in bridge wheel load did not seriously affect the crane runaway structure.

Robert Rice: The paper presented by Mr. Schoen illustrates procedures which can be used not only in ladle cranes but industrial and mill type cranes as well.

First let us think about the idea of reducing weight to a minimum. We have not worked hard enough at reducing machinery weights because, in general, material is inexpensive whereas labor constitutes a large percentage of the cost of a product. Natural resources eventually are used up and our materials, therefore, becomes more expensive so that eventually we shall be forced to use material more sparingly. Even now if we could use our materials more economically without increasing the labor cost, it would result in raising our standard of living with ultimately more products for each of us to use.

It is economically sound to reduce the weight of machinery, especially overhead traveling cranes. If we begin with the design of a hoist of a given capacity and eliminate all excess weight which does not add to the durability or usefulness of the hoist in lifting loads, we can then reduce the weight of the trolley frame which results in lighter bridge girders, smaller trucks, less bridge motor horsepower and smaller drive parts. A good engineering design, therefore, can produce a crane of minimum weight without sacrificing quality or performance. The lighter crane will have lower wheel load which in turn reduces the weight of the runway beams and columns as well as the size of the footings. Still another saving is in the power required to operate the crane throughout its entire life.

Replacing trolleys on old cranes is often a very good investment just as Mr. Schoen found on these three ladle cranes. The heart of a crane is the hoist unit and the older designs are likely to require more maintenance and be out of service for longer periods. A new hoist, therefore, can be designed to do the required work with practically no downtime or maintenance cost which factors alone often justify the investment. For tax purposes, replacing a trolley may sometimes be considered as a repair and may not require an addition to capital investment. The bridge of the old crane may be in relatively good condition and by replacing the wearing parts such as wheels, gearing and bearings, it may be as good as when originally built. This new modern trolley will probably weigh less than the old trolley with its cast frame, bronze bearings and open gearing—thus making it possible to either increase the capacity of the crane or to provide a higher margin of safety in the structural parts and greater service factor in the bridge wearing parts.

In addition to these mechanical changes, it is often desirable to replace the old cab with a new full vision type with magnetic control and other features which make the crane easier and safer to operate. All of these factors were present in the changes described by Mr. Schoen and they are possibilities which should be investigated on old cranes where maintenance is high and more reliability is desired.

R. Tietig, Jr.: The basic problem which Mr. Schoen has so ably discussed probably exists in many older open-hearth shops where the limitation on heat size is really the load carrying capacity of the existing building foundations and pouring crane runway. Hence, the expedient of merely increasing crane capacity by using heavier or stronger components in the crane cannot be followed. Therefore, as Mr. Schoen has shown, the dead weight of the crane must be reduced to allow for an increase in heat size.

In connection with this, mention should be made of the possibility of utilizing aluminum in the bridge construction. Kaiser at its Ravenswood, W. Va., plant recently installed 27 cranes utilizing aluminum wherever possible in their construction. These cranes range from 10 to 125 tons in capacity and were designed to conform with AISE Standard No. 6 for mill type cranes. They were built by standard crane manufacturers at least one of whom is a builder of cranes for hot metal service. These cranes are not of the light industrial type.

Typical of these cranes is one of 100-ton capacity with a 105-ft span. This is a two-girder crane and the weight of the complete girder assembly is 165,000 lb. Had steel replaced the aluminum, the estimated weight of the assembly would have been 310,000 lb, which indicates a reduction in crane girder weight, where aluminum is used in place of steel, of about 47 per cent. Incidentally, the cranes at Ravenswood are of welded construction.

As to the question of cost, the aluminum cranes are about 10 per cent more than their steel counterparts. However, if the comparison is made of the bridges alone, the percentage may be somewhat higher.

Further data on aluminum cranes may be expected in the near future based on actual operating experiences at Ravenswood. When these data are made available, a somewhat different solution to Mr. Schoen's problem may be possible. ▲

Modern trend in temper mills is to increase both speed and power . . . . two stands are a feature of the high production mills . . . . paper gives data for selecting drives and controls.

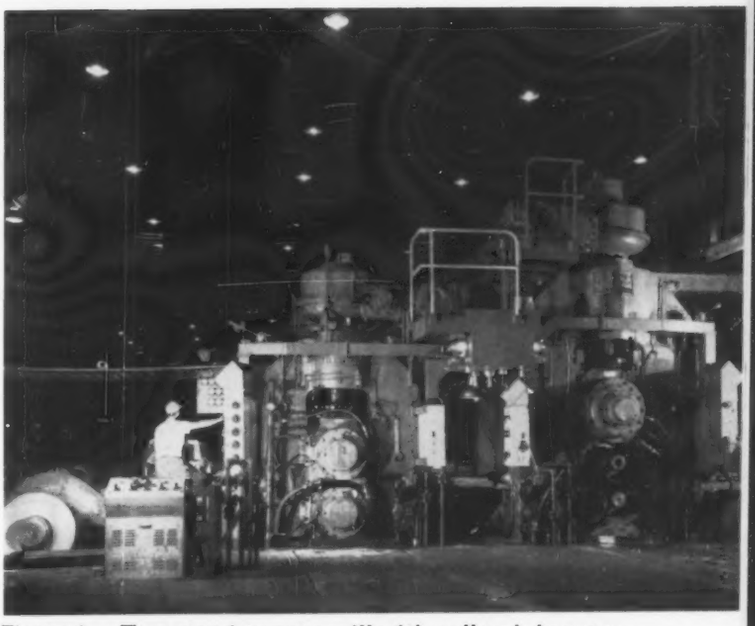


Figure 1 — Two-stand temper mill with pullers is in operation at Weirton Steel Co., Weirton, W. Va.

Selection of Electrical Equipment for Temper and Skin Pass Mills

by J. E. Peebles, J. J. Remley, and R. B. Eggleston, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

TEMPER or skin pass mills as a class include a variety of mills ranging from simple, relatively slow speed single stand sheet mills to complicated 2-stand tinplate mills with pullers, Figure 1. Although a few tandem reduction mills have higher top speeds than the fastest temper mills, in practice, many temper mills consistently operate at top speed which is faster than the normal operating speed for any reduction mill.

There are many facets which must be considered when selecting the electric drive system of a temper mill. The prospective purchaser should first be familiar with the basic operation of a temper mill itself and the role of each mill component. He should understand how drive ratings are determined so he may ascertain if the suggested drive motors of a proposed mill will meet his rolling requirements and operating practices. He should also become familiar with the basic drive system and the performance to be expected.

The simplest form of a temper mill is a single stand 2-high or 4-high mill with a pay-off or feed reel and a tension or winding reel. The coil of soft annealed strip is placed on the pay-off reel. It is uncoiled from this reel, fed through the mill stand and recoiled on the tension reel.

The strip tensions to which reels may be subjected have definite limitations. The strip on the pay-off reel is very soft and usually fairly loosely wound. Therefore, high tensions could easily cause slippage and scratching of the strip. On the tension reel, high tensions might very well result in mis-shaping the strip, or cause buckling of the inner wraps when the coil is stripped from the mandrel. As a result, when higher strip tensions are required, tension devices, commonly called pullers, are introduced between the reels and the main stand. Pullers may be used at only the delivery side or both sides of the main stand. Another function of the puller on the entry side of the mill is its "snubbing" effect on the strip. The strip will not generally leave the pay-off coil smoothly. It will, instead, tend to adhere to the adjacent layer in the coil, jerking loose in sections at a time. If the fluctuation in strip tensions caused by this phenomena were allowed to be imposed on the mill, the strip would be correspondingly marked. By placing a puller between the pay-off reel and the main stand, this fluctuation may be almost entirely damped out.

High-speed tinplate mills consist of two main mill stands with pay-off and tension reels and pullers. The primary function of the first stand is to accomplish rolling work. The second stand, while providing some tempering effect, also imparts flatness and surface finish to the strip.

Apparently, the large investment of a 2-stand mill is justified where mill output must be high and either the tempering required cannot be accomplished in a single

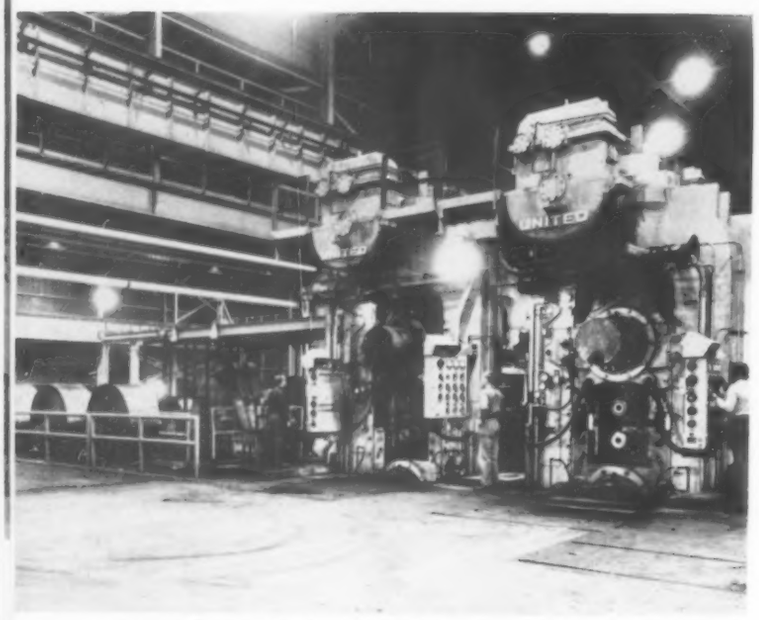
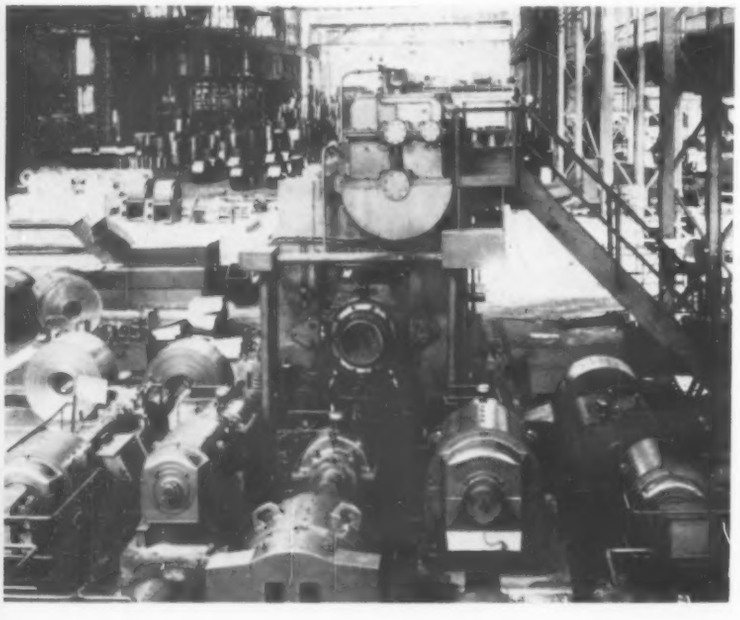


Figure 2 — This two-stand temper mill with pullers is located at Youngstown Sheet and Tube Co., Indiana Harbor Works, Ind.

pass on a single stand mill or the surface quality must be high, such as for tinplate. In general, high surface quality cannot be easily obtained in a pass which is causing any appreciable tempering or reduction. Consequently, single stand mills are used where large tempering effects are not required or where surface quality is not critical, such as hot dip galvanized strip. Low output producers, even when requiring a high quality finish or a large tempering effect usually cannot justify the greater investment of a 2-stand mill. Therefore, they pass the strip through a single stand mill twice, usually changing rolls for the second pass.

In passing through a temper mill, the strip is tempered to an extent indicated by the slight reduction made. The reduction obtained is a function of a combination of roll pressure and strip tension. Strip tension also helps to control strip shape and, together with the working of the strip around the puller rolls, improves surface finish by removing flow lines.

Figure 3 — Drive motors for single stand temper mill with pullers started in 1952 at Breedband, N.V., Ijmuiden, The Netherlands.



The following types of mills are relatively special and are mentioned here only for completeness. Temper mills for sheets normally consist of only a main stand, tempering being accomplished by roll pressure alone. At times, sheet material will come to the mill in coil form and hence a pay-off reel is required. The strip is then often sheared into sheets and piled as it leaves the mill. Occasionally, strip mills are provided with the flexibility to temper sheet as well as strip. These are known as combination mills.

DETERMINATION OF DRIVE RATINGS

Basic motor horsepowers are determined by operating requirements. The size and hardness of the strip, the amount of tempering to be accomplished, strip speed, strip tension and the distribution of this tension throughout the components of the mill, all affect drive horsepower. In turn, some of the above criteria are interdependent on each other. In addition, some motor horsepower capabilities may be dictated by mill accelerating requirements. In general, strip tensions throughout the mill are entirely at the option of the mill operator and a reasonable range of possible strip tensions are made available to him. Such a range of tensions is usually determined by the user or mill builder based on experience with existing temper mills.

Mill stand drive—In a 2-stand mill, most of the actual reduction to the strip is made at Stand No. 1. However, as a result of the high tensions between stands, a portion of the rolling power for this reduction is actually provided by the Stand No. 2 drive motor. In some 2-stand mills, Stand No. 1 drive motor is lightly loaded during rolling as a result of this "power transfer." This, of course, will vary with rolling practice.

Through the years, there have been a number of attempts to determine some empirical relationship which could be utilized to establish the rolling power required by a given temper mill. To date, most of the results thus attained have proved to be inconclusive. In actual practice, many mill owners select the stand drive horsepower on the basis of what has proven satisfactory or unsatisfactory on their existing temper mills. Figures 4 and 5 are charts which indicate the amount of drive horsepower provided for each mill component for a number of recent single-stand and 2-stand temper mills. To facilitate comparison between mills, these horsepowers have been expressed in terms of rated drive horsepower per inch of strip width per 100 fpm of strip speed. These data should prove of value in comparing calculated horsepowers of puller and reel drives of contemplated mills with those of existing mills.

These motors must also accelerate or decelerate the stands in the given time interval. To illustrate the method of determining this accelerating torque requirement, consider the following assumptions and calculations:

Stand drive motor rating—1250 hp
Gear ratio—Direct through 48-in. diam backup rolls
Mill inertia (WK^2) = 203,000 lb-ft^2
Motor inertia (WK^2) = 8700 lb-ft^2
Maximum strip speed = 4000/6000 fpm

Accelerating time = 24 sec

Motor speed (N) at top mill speed:

$$N = \frac{\text{Strip speed}}{\text{driven roll circumference}}$$

$$N = \frac{6000 \text{ fpm}}{\pi \times 48/12} = 478 \text{ rpm}$$

$$\text{Rated motor torque } (T_r) = \frac{5250 \times \text{hp}}{\text{rpm}}$$

$$T_r \text{ @ } 478 \text{ rpm} = \frac{5250 \times 1250 \text{ hp}}{478 \text{ rpm}} = 13{,}730 \text{ lb-ft}$$

$$\text{Required accelerating torque } (T_a) = \frac{WK^2 \times \Delta N}{308 \times t_a}$$

where WK^2 = total inertia of drive and driven system (lb-ft^2)

t_a = time interval for acceleration (sec)

ΔN = change in speed during acceleration (rpm)

$$T_a = \frac{(203{,}000 + 8700) \text{ lb-ft}^2 \times 478 \text{ rpm}}{308 \times 24 \text{ sec}} = 13{,}700 \text{ lb-ft.}$$

This accelerating torque is 100 per cent of the rated full load motor torque. This additional torque requirement should be available in the frequently repeated overload rating of the motor. In general, the inertia of a temper mill stand is comparable to that of a reduction mill. However, since basic rolling power is considerably lower, and therefore corresponding drive motors are smaller, accelerating rates often available on reduction mills are not economically feasible for a temper mill. They could only be obtained by a prohibitively expensive, large increase in motor horsepower. To illustrate this, assume that it was desired to accelerate the mill stand illustrated in the above calculations, in 10 instead of the 24 sec assumed.

$$T_a = \frac{WK^2 \times \Delta N}{308 \times t_a}$$

$$t_a = \frac{(203{,}000 + 8700) \text{ lb-ft}^2 \times 478 \text{ rpm}}{308 \times 10 \text{ sec}} = 32{,}800 \text{ lb-ft.}$$

This accelerating torque is 240 per cent of motor full load torque, which represents a total drive motor peak load of approximately 340 per cent. Obviously, this would result in a large increase in motor capacity which would be required only to provide this higher acceleration.

Most modern high-speed temper mills are purchased to temper roll a very narrow range of strip gage. For mills of this type, only a very small field range is required of the main stand drive motor or motors. This small field range is used to compensate for variations in the driven roll size as a result of roll wear. This field range can be determined as follows. The base speed can be calculated as illustrated earlier in this paper, based on driving the 48-in. backup rolls. $N = \frac{4000 \text{ fpm}}{\pi \ 48/72} =$ 318 rpm. The maximum diameter of these rolls would be 48 in. For these calculations, assume the minimum diameter is 44 in. Motor speed at this smaller diameter can be similarly calculated to be 347 rpm. Motor field range required to compensate for roll wear would be 318/347 rpm. Since the closest standard base speed rating for a motor at this horsepower is 300 rpm, we will assume a speed rating of 300/350 rpm. It has been assumed that

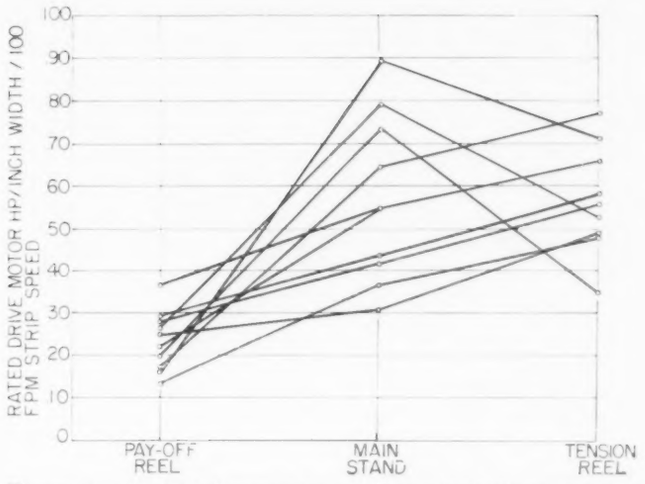


Figure 4 — Installed power on existing single stand temper mills.

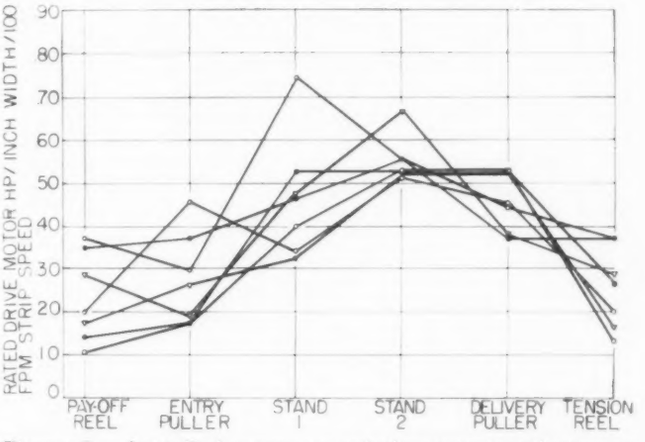


Figure 5 — Installed power on existing two-stand temper mills.

this particular application is direct drive. If it is economically feasible, there are operational and maintenance advantages to a direct drive. However, there are times when the resulting motor speed is not economically feasible for the motor horsepower rating required. In situations such as that, speed reduction or speed increasing gears should be used to obtain the maximum over-all drive economy.

Some mills are required to roll a large range of products. Such mills usually have low-speed requirements when working heavy stock, where torque requirements are high and strip lengths are small. Then, when rolling the lighter gages where torque requirements are low, it will be highly advantageous to roll at a high speed because of the long strip lengths. For such a mill, motor size can be best utilized by providing a field range to cover the range of operations. Then, mill operation with full motor field will provide the low speed, high torque required for rolling the heavier gage material and, with weak field, will provide the high speed, low torque required for rolling the lighter gage strips. The dual speed rating listed earlier for the mill stand indicates that this operating flexibility is required. To provide roll wear compensation and the strip speed rating of 4000/6000 fpm, the complete speed rating of the drive would be 300/550 rpm.

Tension device or puller drive—Strip speed, tension,

puller roll diameter and gear ratio will directly determine the rating of the drive motor or motors. Although most puller drives are direct, there may be instances where a direct drive would result in a motor speed economically infeasible. As with the main stand, reduction or speed increasing gears may be required to obtain an economical over-all drive.

The delivery puller horsepower required to provide desired strip tension may be determined as illustrated by the following calculations, based on the indicated assumptions.

Strip speed = 4000/6000 fpm
Puller roll diameter = 21 in.
Roll directly driven by motor
Maximum change in strip tensions required across puller = 12,000 lb (mill side) to 5000 lb (reel side). These tensions required at 4000 fpm only, constant puller hp up to 6000 fpm.

$$\text{Drive horsepower} = \frac{\text{Strip speed (fpm) x change in tension (lb)}}{33{,}000}$$

$$= \frac{4000 \text{ fpm x } (12{,}000 - 5000) \text{ lb}}{33{,}000}$$

Drive horsepower = 849 hp, assume 900 hp will be furnished.

$$\text{Motor base speed (N)} = \frac{\text{Strip speed}}{\text{roll circumference}}$$

$$N = \frac{4000 \text{ fpm}}{\pi\ 21/12} = 728 \text{ rpm}$$

Puller motor torque requirements to meet the established accelerating rates may be determined in the same manner as illustrated for the main stand drive motors. Once total puller horsepower is determined, there are a number of ways it may be applied to the puller. First, let us consider what limitations there are when applying power to a puller roll. Assuming the two rolls do not pinch the strip, each roll is simply a belt and pulley arrangement with an angle of wrap as indicated in Figure 6.

The equation applying to belt drives on a pulley, found in any mechanical engineering handbook, establishes the maximum increase in strip tension around a single roll as:

$$T_2/T_1 = \epsilon^{\theta f}$$

where T_2/T_1 = ratio of tension across the roll
ϵ = constant of 2.72
θ = angle of wrap of radians
f = coefficient of friction between the rolls and the strip—assumed to be 0.18

The listing below gives values of T_2/T_1 for a number of different values of wrap angle.

θ, degrees	T_2/T_1
120	1.46
140	1.55
160	1.65
180	1.76
200	1.87

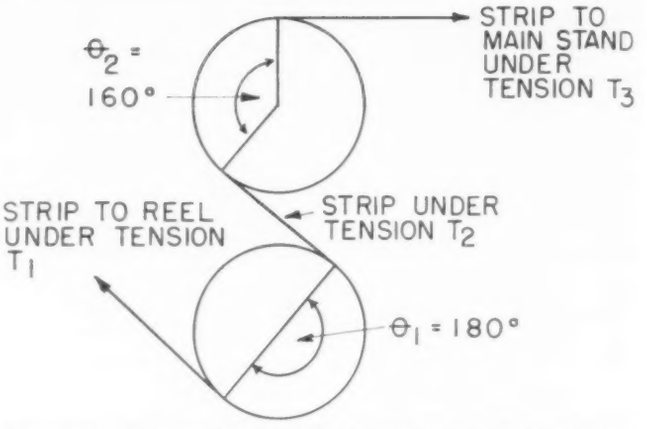


Figure 6 — Puller rolls sketch shows wrap of strip around rolls.

The total increase in strip tension across a pair of puller rolls may be expressed as follows:

$$T_3/T_1 = T_3/T_2 \text{ x } T_2/T_1 = \epsilon^{\theta_1 f} \times \epsilon^{\theta_2 f} = \epsilon^{f(\theta_1 + \theta_2)}$$

The table of values of T_2/T_1 can easily be applied for any combination of wrap angles. For example, the sketch indicates angles of 160 on the top roll and 180 degrees on the bottom roll. To determine a corresponding T_3/T_1, simply multiply T_2/T_1 at 180 degrees (1.76) by T_2/T_1 at 160 degrees (1.65). The total theoretically tension multiplication would be, therefore, approximately 2.9. If maximum puller horsepower is based on a schedule of strip tensions which never require the puller to increase strip tensions by more than the appropriate T_2/T_1 factor available across one roll as listed above, it is possible to drive only the one roll of the puller. However, if additional tension is required, both rolls of the puller are driven. The tension increase through a puller with both rolls driven may theoretically be as high as the T_3/T_1 ratio, calculated using a 0.18 coefficient of friction, if the relative sizes of the puller roll motors are calculated from values of T_1, T_2 and T_3.

This optimum ratio is frequently modified for the convenience of sizing drive motors. One such possible modification is to provide three identical armatures for the puller, which is highly advantageous when stocking spares. One armature would drive the puller roll at the reel end of the strip and the other two armatures would form a double armature drive for the other roll. The puller drive of the sample calculations could therefore be furnished as one 600-hp drive of double armature construction utilizing two 300-hp armatures and one single armature 300-hp drive. In this case, the ratio of roll power would probably be regulated to 2 to 1, to take advantage of maximum drive capability.

There will normally be some field range provided in the drive motor to allow for variation in roll size. These puller motors may also be provided with additional field range to permit the flexibility of rolling heavy material at low speed and high tensions or light strip at high speed and low tensions. Complete actual puller motor speed ratings are determined in a manner similar to that described for the main stand drives.

Pay-off and tension reel drives—A reel and its drive may take several forms. On some small temper mills, where reel power is small, the pay-off or unwind reel may be supplied with a friction device to enable it to

hold back-tension on the strip as it enters the main mill stand. On most temper mills, the pay-off reel is provided with a drag generator which maintains back-tension by pumping power back into the electrical system. The tension or winding reel must always be provided with a drive motor to enable it to wind the strip into a coil as it leaves the mill.

The pay-off reel may be constructed in the form of either an expanding mandrel or opposing cones. The coil will be less likely to slip on the mandrel-type reel since the expanding surfaces of the mandrel press on the entire inner surface of the coil. The opposing cones, in contrast, contact only the edges of the inner wraps. The opposing cone-type reel, however, will handle a larger range of coil inner diameters. Loose inner wraps will greatly hamper threading a mandrel through a coil but will not affect the ease with which the coil may be engaged by an opposing cone-type reel.

The tension reel is normally of expanding mandrel-type construction. The end of the strip is actually gripped by jaws on some reels, thereby preventing any possibility of slippage. When it is desired to thread the mill "on-the-fly," a belt-wrapper is used to guide the moving strip around the mandrel. After a few turns, friction will hold the strip on the mandrel firmly enough to withstand strip tension.

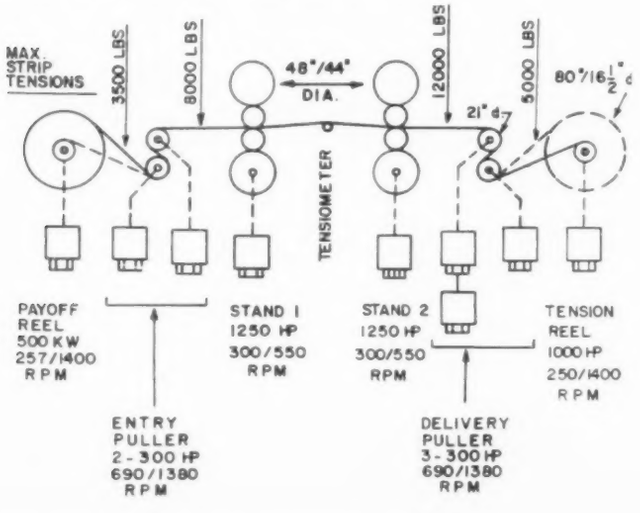
As in the case of the pullers, strip tension and speed establish reel horsepower requirements. To illustrate the necessary calculations, the following assumptions are made for a typical tension reel:

Strip speed = 4000/6000 fpm—corresponding reel speed range is obtained by adjusting armature voltage
Accelerating time = 24 sec
Strip tension = 5000 lb
Reel mandrel diam = 16½ in.
Strip width = 46 in.
Maximum coil diam = 80 in.
Inertias (WK^2) Motor = 10,000 lb-ft²
Reel = 6200 lb-ft²
Reel directly driven

$$\text{Drive horsepower} = \frac{\text{Strip speed (fpm)} \times \text{tension (lb)}}{33{,}000}$$

$$= \frac{6000 \text{ fpm} \times 5000 \text{ lb}}{33{,}000} = 909 \text{ hp}$$

Figure 7 — Drive motor ratings of two-stand temper mill which are used in sample calculations.



Maximum motor speed = 6000 fpm/mandrel circumference

$$N = \frac{6000}{\pi \times 16.5/12} = 1390 \text{ rpm}$$

Minimum motor speed = 6000 fpm/coil maximum circumference

$$N = \frac{6000}{\pi\ 80/12} = 286 \text{ rpm}$$

For a conservative selection of motor speed, the calculated base speed is normally reduced 5 per cent. Therefore, this reel motor would have a speed rating of 270/1390 rpm. Here again, the nearest standard speed rating is 250/1400 rpm. The motor horsepower rating will be assumed to be 1000.

The calculation of required accelerating torque for the reels is complicated by the fact that the inertia of the reel changes as the coil builds up or builds down. It is desirable to evaluate motor accelerating requirements in terms of its full load capacity. The following derivation is used to obtain a formula with which a value of accelerating current may be readily obtained.

Per cent accelerating current (I_a) = (T_a/T_r) x 100 per cent

where T_a = required accelerating torque (lb-ft)
T_r = rated motor torque (lb-ft)

but $T_a = \dfrac{WK^2 \times N}{308 \times t_a}$ and $T_r = \dfrac{hp \times 5250}{N}$

where WK^2 = total inertia of system being accelerated (lb-ft²)
N = speed to which motor is accelerating from standstill (rpm)
hp = rated horsepower of motor
t_a = time of acceleration (sec)

$$\text{therefore, per cent } I_a = \frac{WK^2 \times N^2}{hp \times t_a \times 16{,}170}$$

The particular motor under consideration is the 1000-hp tension reel drive and the accelerating time is 24 sec. Substituting these values into this general equation will result in an equation which may be used to calculate the accelerating current for this reel at any point of coil build-up.

$$\text{Per cent } I_a = \frac{WK^2 \times N^2}{38.8 \times 10^7}$$

The nomogram of Figure 8 represents a convenient method of rapidly determining the approximate inertia of a coil at various points of build-up.

To illustrate these calculations further, consider the point of reel build-up where a full reel has been obtained and the motor speed is 286 rpm.

WK^2 = 1000 lb-ft² for the motor
+ 6200 lb-ft² for the reel
+ 363,000 lb-ft² for the coil
Total WK^2 = 370,200 lb-ft²

$$\text{Per cent } I_a = \frac{WK^2 \times N^2}{38.8 \times 10^7}$$

$$= \frac{370{,}200 \times 286^2}{38.8 \times 10^7} = 78.0 \text{ per cent}$$

The curve in Figure 9 indicates the total per cent motor current which would be required by the above

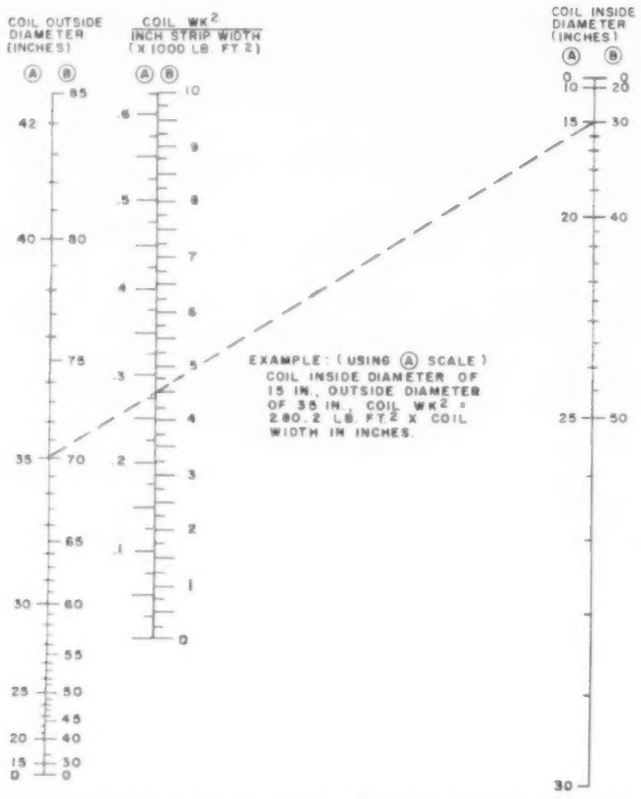

COIL OUTSIDE DIAMETER (INCHES)
COIL WK²
INCH STRIP WIDTH
(X 1000 LB. FT.²)
COIL INSIDE DIAMETER (INCHES)
EXAMPLE: (USING Ⓐ SCALE)
COIL INSIDE DIAMETER OF 15 IN., OUTSIDE DIAMETER OF 35 IN., COIL WK² = 280.2 LB. FT.² X COIL WIDTH IN INCHES.

Figure 8 — Nomogram gives WK² of large steel coils of various diameters assuming no space between wraps and 489 lb per cu ft steel.

reel motor to accelerate at a constant rate during coil build-up. The current plotted is the accelerating current superimposed on the normal tension load current required, which is assumed to be 100 per cent.

GENERAL MOTOR CONSIDERATIONS

Once the basic horsepower and speed of the drive motors of a mill have been determined, the entire mill should be re-examined. It may be very likely that acceleration considerations should be ignored until this time. Now, each mill component should be studied to determine what acceleration it is capable of attaining with the drive motor size as determined by steady state load. This will indicate the mill accelerating rate which is possible without increasing motor sizes. It will also indicate if any one mill component has an accelerating rate capability considerably lower than the rest of the mill. Should this be the case, it would probably be economical to improve over-all mill performance by increasing the size of this one drive.

There are occasions when a given mill component accelerating rate can be improved by providing a low inertia drive motor. The motor inertia can be reduced slightly by using a high temperature insulation. If this is not sufficient, the motor inertia can be reduced further by special motor design, constructing the motor with a smaller diameter but greater length. Finally, in an effort to obtain a lower motor inertia, the motor can be of double armature construction.

The mill motors should also be studied to determine if some of the motors can be duplicates by merely modifying the rating slightly, without sacrificing mill performance. Though such modification may cost slightly more initially, it will frequently be more than offset in savings should the mill owner wish to back up all his mill motors with spare armatures.

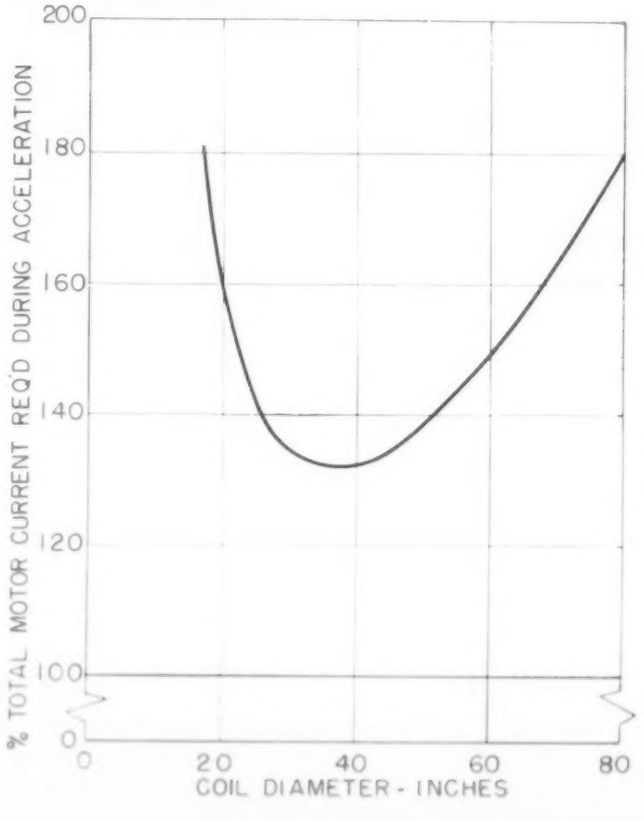
Another motor feature which must be considered is the ability to withstand end thrust. Such thrust would exist as a result of spindle misalinement or might occur during roll changing. A reasonable value of end thrust capability should be specified when ordering a drive motor. It is not feasible to design a motor to be capable of withstanding the extremely high thrust possible upon a shaft breakage. Therefore, the mill design must be such as to prevent any such thrust from being transmitted to the motor, if it is not to be damaged upon such a failure.

Still another factor affecting the drive motors is whether there are any severe size limitations. Although such size restrictions may arise in regard to the length of a drive motor, they are more apt to occur in regard to its diameter. Very often, main stand work rolls or puller rolls are twin-driven by direct-connected motors. These driven rolls are frequently of such a small diameter that it consequently imposes a severe limitation on the diameter of the drive motor. Such drive motors are often forced to double armature construction to meet this restriction.

POWER SUPPLY

Common bus vs individual generators—One of the most widely discussed phases of generator selection is the use of individual generators versus use of a common generator bus. A common bus system provides one or more main generators for all the drive motors of the mill. Normally, one drive motor is placed directly across the bus and its voltage regulating circuit paces the entire

Figure 9 — Curve gives reel motor load and acceleration current vs coil build-up.



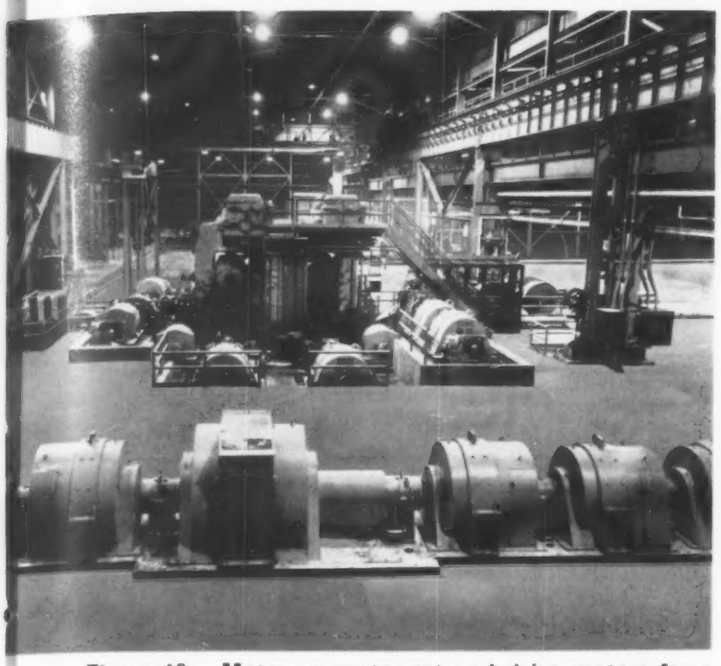


Figure 10 — Motor-generator set and drive motors for a two-stand temper mill at Youngstown Sheet and Tube Co., Indiana Harbor Works, Ind.

mill by controlling bus voltage level. Low voltage, high current generators, called boosters, are placed in series with each of the remaining main drive motors across the main bus. These booster generators are then used to buck or boost the bus voltage to meet the voltage requirement of each particular armature.

In an individual generator system, a separate generator is supplied to power the drive motor or motors of each mill component. Figure 10 illustrates a mill with individual generators. One of the principal advantages of the use of individual generators is the greater flexibility of operation which they provide. With such a system, any motor can be operated from zero to its rated voltage completely independent of any other motor. In contrast, with a common bus system, the voltage at which a given motor can operate is limited to the bus voltage plus or minus the voltage range of the associated booster generator. It is obvious that booster generator voltage rating must be carefully selected.

Another advantage of individual generators is that the potential short circuit current is reduced because there are several independent circuits. This arrangement makes it possible to use contactors in the armature circuit of some mills where circuit breakers would be required with one large common generator.

On an individual generator mill where the payoff drag generator is of small size, this drive may be rated 250 volts while the larger motors may be rated at a higher voltage. A motor will usually have a standard voltage rating which represents an economic optimum. Voltages other than this standard rating will add to the cost of the motor. However, when a common bus is used, the voltage is selected to be most economical when considering the main generator and all of the motors connected to this bus. There will obviously be occasions when the voltage thus selected for the main bus will not be the most economical voltage for a particular motor driven from this bus.

A motor generator set with only one common generator may be considerably shorter than a set consisting of individual generators, particular for a 2-stand mill with pullers requiring a total of six main generators. However, the common bus system will require additional equipment such as booster motor-generator sets and associated control for which space must be provided. This additional equipment may or may not consist of relatively small units.

As with any equipment, relative cost is a major factor when deciding upon either a common bus or an individual generator system. The strongest argument for a common bus system is that it is usually less expensive for temper mills. A large part of the motor capacity of a temper mill is used to obtain tension. Hence, this power is merely transferred between motors within the mill, total motor capacity not being representative of the actual power required to obtain temper. A common generator may be sized on the basis of the actual work done on the strip, the so-called tension power just being transferred directly between motors through the main bus. Its capacity may be considerably less than the total motor capacity of the mill. In contrast, the individual generator system requires total generator capacity comparable to the total motor capacity of the mill.

Generator selection—Generators for individual drive motors should be selected to have a rating consistent with the rating of the motor they will power. Not only should they be capable of carrying full load motor current at rated voltage continuously, they should also have comparable short time overload ratings. The approximate generator rating may be determined by multiplying the motor horsepower rating by 0.8. This factor converts horsepower to kilowatts and includes an assumption of motor efficiency. When small machines are considered, the generator voltage rating may be greater than that for the motor. This must then be factored into these calculations by multiplying the calculated generator kilowatt rating by the ratio of generator voltage over motor voltage.

When selecting a common generator to supply all the drive motors of a temper mill, a conservative selection is normally made based on the power requirements of all motors taking power from the bus. The regenerative action of motors such as the pay-off reel drag generator, is ignored. The generator rating may then be determined in a manner similar to that used for the individual type generator, except on the basis of total horsepower.

Booster generator selection—The following are factors affecting the selection of booster generators.

1. Main stand drive motor field range.
2. IR drop of the motor under consideration.
3. Voltage drop across current measuring resistors in the armature circuit, if used.
4. Permissible variations in work roll diameters.
5. Variations in motor field temperatures.
6. Draft or reduction in the strip.
7. Rheostat tracking error.
8. Additional armature circuit voltage drop as required for inertia compensation during acceleration and deceleration.

Sample calculations to determine a booster generator rating are included in the appendix to illustrate how these factors are evaluated when selecting a booster generator.

GENERAL MACHINE CONSIDERATIONS

Machine accessories—The reel drives of a temper mill are normally provided with solenoid-operated brakes. The function of these brakes is to obtain positive braking of the reel when jogging for positioning. In general, this brake is sized from one-fourth to one-third of the full load, full field torque of the reel motor. There are occasions, such as handling extremely large coils on the pay-off reel, where a larger brake would definitely improve the positioning operation. Then, this added consideration should be balanced against added cost and inertia when selecting the brake. On larger reel drives, use of the largest brake available will provide less then one-fourth of motor torque.

Overspeed devices are usually provided for the drive motors. Though they may be justifiably omitted on some small motors, they should always be used on larger motors. A large motor has less overspeed capability and the installation of an overspeed device represents a very small percentage of additional investment.

Bearing temperature relays are available for the larger machines. When available, this device is easily justified. It will detect a bearing failure quickly enough to limit damage to the bearing journal.

Space heaters should also be used with large machines. They can be very easily installed in the foundations of such machines. When not running, these machines, requiring large foundations, are much more likely to be exposed to moist air as a result of natural ventilation.

Ventilation—Main mill drive motors are always provided with forced ventilation. This is required since these motors are to be capable of operating at very slow speeds or holding tension while not rotating. Smaller machines may have motor-mounted blowers which force air into the machine. These blowers may also be provided with filters or unit coolers. Large machines are provided with a separate ventilation system consisting of fans and a filter. Should this system be recirculating, rather than non-recirculating, a heat exchanger to cool the air is also included. If these machines are located in the mill area, they would be enclosed for up-draft ventilation. The air would then be supplied to the machine from ducts or tunnels under the floor, blown through the machine and exhausted into the mill area.

When the machines are located in a motor room, it is possible and quite advantageous to utilize down-draft ventilation. With such a system, the filtered cooling air is blown into the motor room where it is drawn through the machines by exhaust fans. As a result, the motor room contains clean, cool air rather than the relatively dirty and hot exhaust air. The maintenance advantages are quite obvious. S. L. Jameson's paper "Ventilation of Steel Mill Equipment" 1955 Proceedings AISE may be referred to for a complete description of ventilation systems and actual system design considerations.

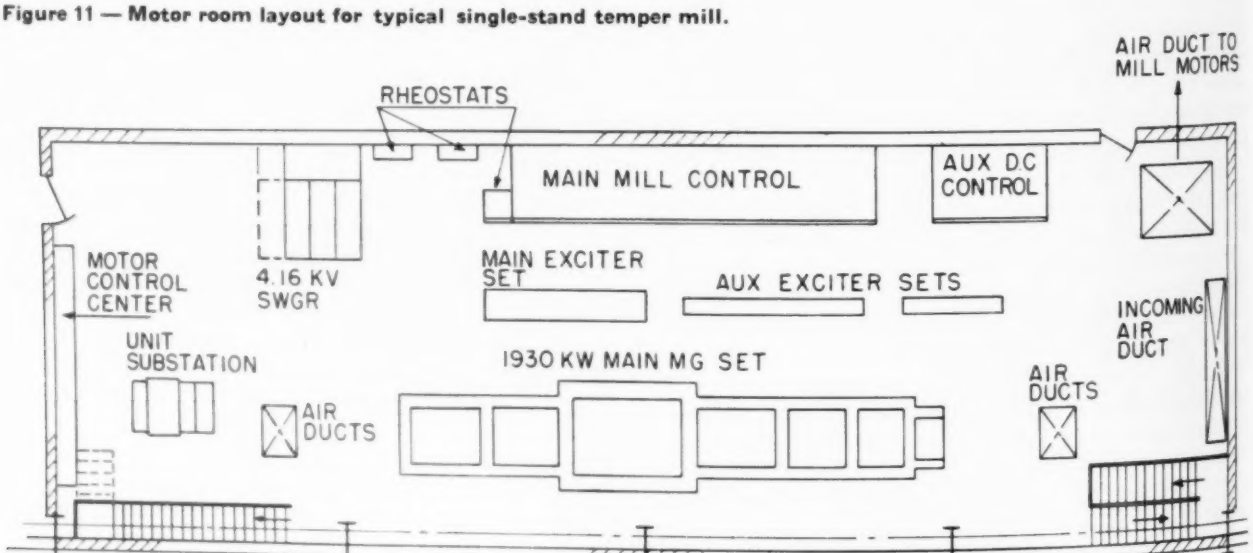
Motor room arrangement—The space requirements of the electric equipment of a new mill will be of great concern to a user. A motor room generally is provided to contain such equipment as the main motor-generator set, auxiliary motor-generator sets consisting of exciters and possible rotating amplifiers, main and auxiliary d-c control panels, a-c motor control equipment for mill auxiliary drives and the motor-generator sets and possibly an a-c substation. A typical motor room arrangement for a single stand temper mill is illustrated by Figure 11.

In laying out a motor room, there are many factors to be considered. In addition to studying relative equipment location to facilitate operational and maintenance work, equipment should be located to minimize conduit, cable and bus work lengths and interferences. Equipment must be provided with minimum clearances for accessibility while still keeping a compact arrangement. As an indication of the motor room area which may be required, a recently installed 2-stand temper mill with pullers and a total drive horsepower of 7500 hp was provided with a motor room of approximately 6000 sq ft in area. This motor room contained the main motor-generator set and the other electric equipment mentioned above. By contrast, the motor room of Figure 11 for a single-stand temper mill with pullers and a total drive horsepower of 2400 hp has a floor area of approximately 3200 sq ft.

CONTROL SYSTEMS

Actual operator's controls may be provided on desks located near the mill or on control cabinets (Figure 12)

Figure 11 — Motor room layout for typical single-stand temper mill.



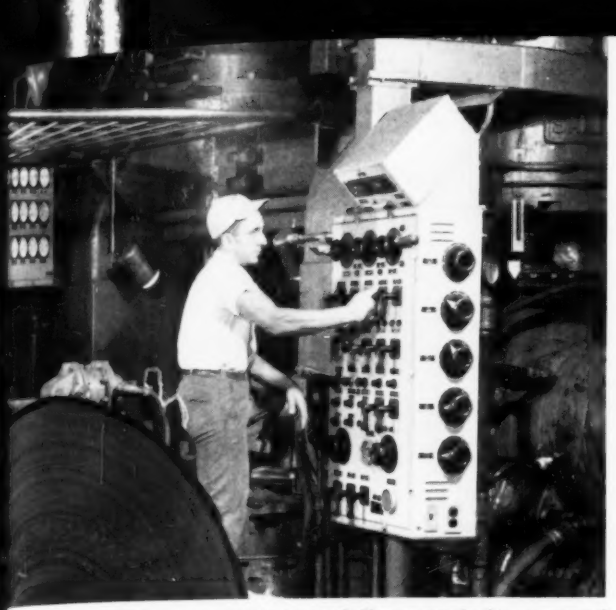


Figure 12 — Operators cabinet at delivery end of two-stand temper mill.

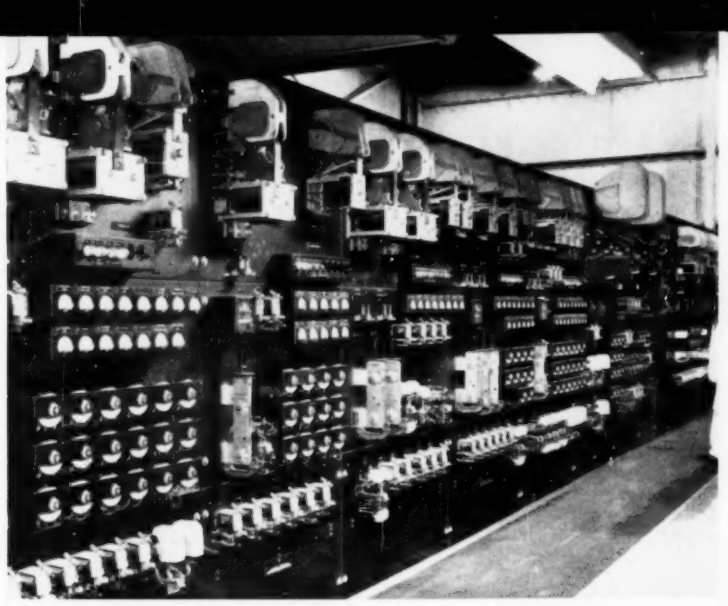


Figure 13 — Main d-c control panels are usually of open construction.

mounted directly on the mill housing. Main d-c control panels are generally of open construction and are located in a separate control or motor room (Figure 13). In outlining the fundamentals of control systems, only 2-stand mills with two pullers and reels will be considered since the control for other forms of temper mills are generally simplifications of this basic control.

A motor-operated master rheostat is used to establish mill speed and accelerating rate. The position of this master rheostat determines the speed at which the mill will operate. The rate at which the master rheostat changes position determines the acceleration rate of the mill.

Stand No. 2 control—Stand No. 2 will normally pace the mill. The stand motor speed is normally established by regulating generator voltage. A signal proportional to voltage is compared to a signal determined by the position of the master rheostat. Any error is then corrected by modifying the generator voltage. On systems employing a common generator, this generator voltage established the voltage level of the bus.

On smaller mills, where regulating control is not economically justified, the rheostat is inserted directly in the generator field circuit. The generator voltage is merely allowed to follow the position of the master rheostat within the limitations of the natural response of the generator. The stand will lag somewhat behind the travel of the rheostat and creep to its final speed.

Stand No. 1 control—Stand No. 1 should run so as to maintain a given amount of tension between the two main stands. Since some of the power in each stand is consumed by the rolling load, it is not possible to detect tension between stands by measuring and comparing motor inputs. Tension must be measured directly.

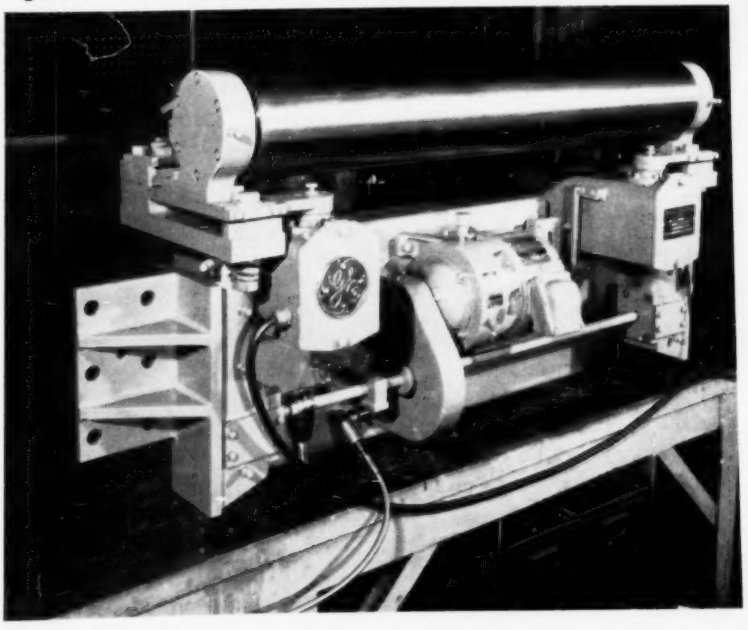
A voltage regulator, similar to that for Stand No. 2, will approximately speed-match the two main stands by adjusting armature voltage. A tensiometer is located between the stands to provide a signal proportional to strip tension (Figure 14). This signal is compared to the tension set by the operator and the amplified error acts as a vernier on the voltage regulator to maintain desired strip tension.

The tensiometer is designed to deflect the strip slightly. The resultant force opposes the tensiometer spring constant to provide a tensiometer deflection proportional to strip tension. The deflection is converted into an electrical signal by an electro-magnetic system.

Puller control—Basic regulating circuits of the entry and the delivery pullers are usually identical. The amount of tension which a puller will add to or subtract from the strip is directly proportional to motor torque. Since these motors run with fixed fields, the motor torque, and consequently the change in strip tension, is proportional to motor current.

A voltage regulator adjusts puller motor armature voltage to that value required for an approximate speed-match with the main stands. A high gain current regulator then acts as a vernier to this voltage regulator to maintain the desired increase or decrease in strip tension across the puller. When a puller accelerates, the motor must provide an additional torque component to accelerate the inertia of the motor and puller rolls at the established rate of acceleration. It is then necessary to modify the regulated value of current by that value of current required to compensate for inertia or accelerating torque if strip tensions are to remain unchanged.

Figure 14 — Tensiometer is used with a cold strip mill.



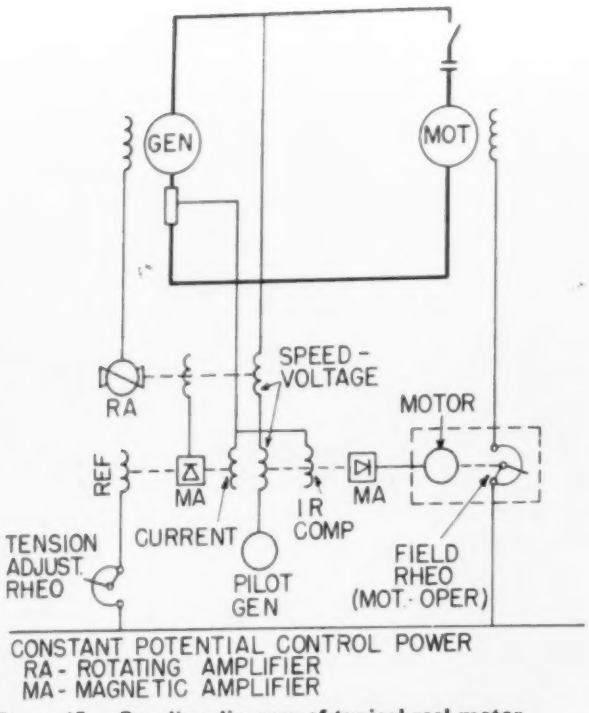


Figure 15 — One-line diagram of typical reel motor.

Reel control—The basic regulating circuits of the pay-off reel and the tension reel are identical. To simplify the following discussion, only the tension reel will be considered.

While rolling a coil, the speed of the strip will be held constant by Stand No. 2, completely independent of the tension reel. The function of the tension reel, in addition to winding the strip into a coil, is to hold constant tension in the strip. As the coil on the tension reel builds up, the over-all coil diameter and circumference will increase. With constant strip speed, the motor will be forced to turn more slowly. The motor current will then increase. However, with a larger coil and the resulting longer "lever arm," motor torque must increase to maintain constant strip tension. The inherent characteristics of the d-c shunt machine is such that by increasing the motor field, armature current may be kept constant as the motor speed decreases. This stronger field and constant current will also provide the required greater motor torque.

Typical regulating circuits for a tension reel are illustrated in the simplified diagram, Figure 15. Regulator circuits essentially consist of a current regulator controlling generator voltage and a counter emf regulator controlling motor field strength.

The current regulator acts as a vernier on the reel generator voltage regulator. Its role is to maintain constant strip tension during normal constant strip speed operation and during acceleration and deceleration of the mill. As the mill accelerates, it is necessary to provide an additional torque component to the reel to meet this accelerating rate if strip tension is to remain unchanged. In a manner similar to that for the pullers, the reel motor current being regulated must be modified by that amount representative of the required accelerating torque. This control function is called inertia compensation.

A motor-operated rheostat is normally used to control the reel motor field excitation. When used with smaller

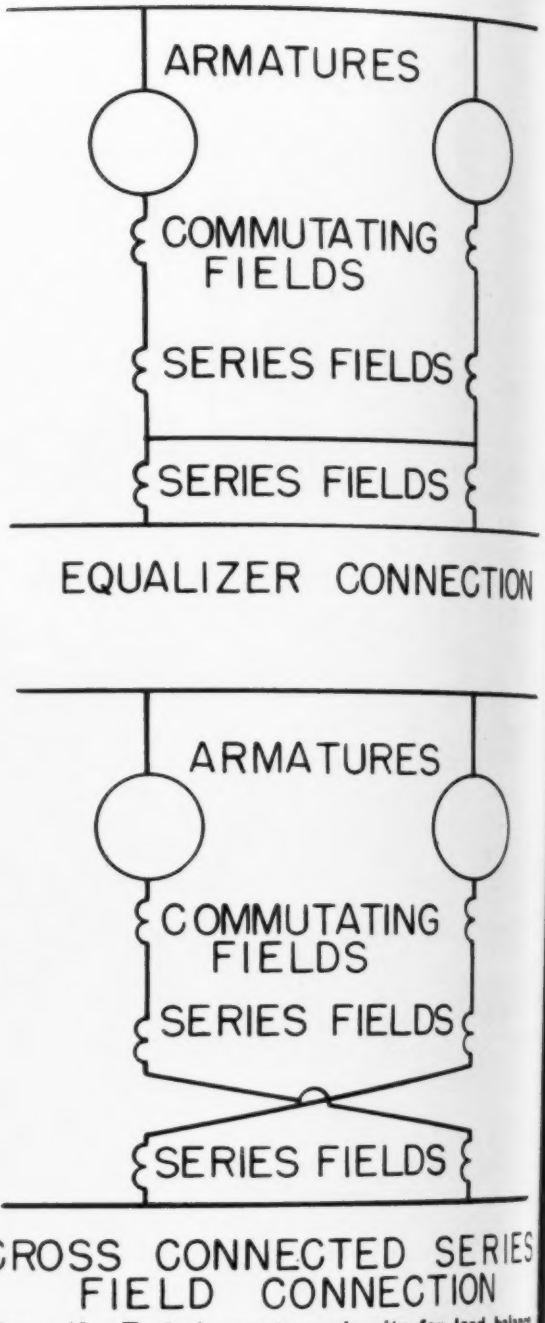


Figure 16 — Typical armature circuits for load balance with split series fields.

motors, this rheostat is placed directly in the field circuit, controlling field current directly. When larger motors are used, a motor field exciter must be inserted between the rheostat and the motor field. Here, a motor field current regulating function should be provided. With a motor field exciter, inherent motor excitation drift due to temperature variations is appreciable. This drift will be entirely eliminated by the field current regulator.

Load balance—Often, there is more than one motor or armature driving a given mill component. Such drives may be provided as twin drives, double armatures or combinations of both. The total load demanded of the component drive will be regulated where necessary as described earlier in this paper. Some means must be provided to divide this total load demand correctly between the multiple drives.

This load balance may be accomplished several ways. Many machines of double-armature construction have each armature rated at half generator voltage. Since these machines have a positive mechanical coupling, their speeds must be the same. If the two fields are maintained at the same strength, the counter emf of each armature will be the same. Therefore, by placing the armatures in series across the generator bus and thus assuring identical armature currents, the load must be equally shared. This method of load balance cannot be used where there is no positive mechanical connection between the armatures. For example, consider such an arrangement provided for the two drives of a cone-type pay-off reel. Should one cone slip in the coil, its speed and counter emf would increase to the point where it would be running at double speed, double voltage while the nonslipping cone drive would stall.

When double armatures are of full voltage construction or when twin drives are considered, some other means of load balance must be considered. Effective load balance can be obtained by giving the motor a large speed droop. Resistors may be placed in series with the armatures of small motors to obtain this droop. Large motors, where series resistors would be prohibitively expensive and would consume a large amount of power, may be supplied with a series field to obtain this speed droop.

Series fields may also be used to provide load balance by an equalizer connection or a cross-connected series field, as indicated by Figure 16. The cross-connected series field is perhaps a more effective method of accomplishing load balance. However, it requires two additional, full current rated connections between the two armature circuits. In contrast, the equalizer connection requires only one, low resistance connection between armature circuits. This connection also facilitates modifying armature circuits to use only one motor when the other is disabled. When the diameter of the motor is limited to a small size because of severe space restrictions, it may be extremely difficult or impossible to find room in the motor for these series fields. Hence, load balancing by series fields would not be used.

Still another method of load balancing is by use of load balance regulators. These regulators will maintain load balance at an adjustable ratio by controlling motor field or armature voltage. This method has the advantages of more accurate load balance and ease of adjustment of this balance. When load balance is being considered for pullers, this method is highly advantageous if not mandatory, because of the flexibility of adjustment. Table I provides a convenient reference as to the recommended use of the various methods of load balance.

Mill thread—There are two basic approaches to threading strip in the mill. The strip may be jogged through the mill by jogging succeeding components, individually or in tandem. On the simpler forms of temper mills, this method of threading the mill is quite satisfactory. However, on the high-speed, 2-stand temper mills with pullers, satisfactory tandem jogging is difficult to attain. With the strip engaged in several of the main mill components, it is extremely difficult to adjust the mill to jog all the components uniformly so to avoid any slack in the strip or tensions in excess of the strength of the strip.

A second method of threading the mill is to run the entire mill at a speed sufficiently slow to enable the operator to thread the strip through the entire mill without stopping. This is commonly known as threading on the fly. It is accomplished by running the master rheostat which establishes mill speed, up to a small portion of its total travel. However, since there is no strip connecting mill components during most of this operation, the conventional regulating circuits will not function properly. They must be modified to result in each succeeding mill component being driven slightly faster than the preceding component. Then as the strip enters each component, it will be quickly pulled taut. As the strip is finally threaded through to the tension reel, it will be quickly wrapped tightly around the mandrel. With this method, a minimum of time is lost when threading the mill.

Reel automatic slowdown—Pay-off reels on recent high-speed mills are being provided with an automatic slowdown which reduces the main mill speed as the reel approaches empty mandrel condition. This prevents the

TABLE I

Chart Indicating Recommended Practice in Applying Various Methods of Load Balance Between Armatures of a Common Drive

Drive identification and armatures being load balanced	Cross-connected or equalizer series field connections	Speed droop (normal or by line resistors)	Series armature connection	Load balance Regulator—armature voltage	Load balance Regulator—motor field
1. Payoff reel					
Double armature (mandrel-type)	X	X	X		
Two motors (opposing cones)		X			
2. Entry puller					
Double armature top and bottom Roll motors	X	X	X	X	X
3. Stand No. 1					
Double armature	X	X	X		
Twin drive	X	X			X
4. Stand No. 2					
Double armature	X	X	X		
Twin drive	X	X			X
5. Delivery puller					
Double armature top and bottom Roll motors	X	X	X	X	X
6. Tension reel double armature	X	X	X		

end of the strip from leaving the mandrel at high speed with the resultant danger to equipment and operators. It also prevents the mandrel from being rotated at the high speed corresponding to empty mandrel without strip wrapped tightly around. The expanding type mandrel may not be mechanically strong enough to withstand the resulting high centrifugal forces without the support of the coil.

Additional control features—An operational feature frequently provided for Stand No. 2 is turning for roll polishing. This is accomplished by de-selecting the reels, pullers and Stand No. 1, and then running the stand at a slow speed with the master rheostat. Obviously, variations of this function as needed to meet a mill owner's requirement are available.

It may be desired to operate a 2-stand temper mill as a single stand mill. However, all the magnetic interlocking and the regulating circuits are designed on the basis of all components of the mill running together in a coordinated manner. To operate the mill without one of the stands, it is necessary to add a selector switch which deenergizes the magnetic circuit of the unused stand main contactor and modifies both the remaining magnetic control interlocking and the regulating circuits. If only Stand No. 2 is used, the regulating circuit of Stand No. 1 is made inoperative and Stand No. 2 regulating circuit essentially operates in a normal fashion, establishing mill speed.

For any of the preceding basic operating functions, modifications to meet a particular customers requirement are usually available. A future user, because he will actually operate the mill, must accept the responsibility of studying his contemplated operating procedure and recognize and specify special functions which may be desired.

NEW DEVELOPMENTS

There are a number of different aspects of temper mills which may see changes as modern technology progresses. One aspect which should be studied when considering a new high speed mill is increasing the level of automation. Some of the latest 2-stand mills, in tempering huge coils of tinplate, 7 ft in diameter, attain strip speeds of 6000 fpm. The higher speeds and the consequently larger horsepower drives and greater investments can be economically justified only if utilized. To obtain the maximum output from a new mill, the overall operating cycle should be studied to use the top mill speed as effectively as possible. Obvious factors would be improved coil handling and roll changing equipment. It may be that in operations such as these lie the greatest opportunities and gains in applying automation to temper mills.

There are devices available which continually measure strip elongation as an indication of strip tempering effort. Strip speed leaving the mill is compared to strip speed entering the mill, the speed ratio being an indication of the per cent elongation. This device has been supplied with an indicating recorder, serving both as an aid to the operator during rolling and as a permanent indication of the amount of work done on the strip.

There are two approaches when contemplating use of data processing equipment on temper mills. First, consider this mill as a location to obtain that strip data which will give an indication of mill performance and essential strip characteristics. Such data might include elongation, strip hardness entering and leaving the mill, roll pressure and possible total power input. It would appear that data concerning other strip characteristics such as length and thickness could be more conveniently obtained at other mills or points of strip processing.

A second approach to data processing at a temper mill would be when considering an over-all system of data processing. Such a system would be utilized to obtain a complete, detailed record of a coil, or whatever form the end-product may take, and the operation performed upon it as it is gradually transformed from its original form, perhaps an ingot. It will likely include automatic processing of cost and price data, wage rate and bonus calculations, and other business information. Here, more complete strip or coil data may be justifiably obtained at the temper mill to complete the over-all record of operation.

SUMMARY

With a basic understanding of the electric drive system of a temper mill and the methods used to determine drive ratings, the user can determine the probable performance of a proposed mill. Automation of material handling, use of newly developed instrumentation and numerical data recording and processing will help to insure full realization of potential performance and production.

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APPENDIX

SAMPLE CALCULATION TO DETERMINE BOOSTER GENERATOR RATING

The sample calculations following illustrate how various factors affect the rating of a booster generator. The particular booster generator considered is that for the bottom roll drive motor of an entry puller.

Assume—Main drive motor rating:
1250 hp, 300/550 rpm, 600 volt.
Direct drive to backup rolls.
From previous calculations, with 48-in. rolls, 6000-fpm strip speed, motor speed is 478 rpm.

Entry puller bottom roll drive rating:
300 hp, 690/1380 rpm, 600 volt.
Direct drive.

Mill data:
Maximum backup roll diam = 48 in.
Minimum backup roll diam = 44 in.
Puller roll diam = 21 in.

1. To illustrate the effect of main stand field range, it is assumed that the main stand motor accelerates with full field from standstill to base speed by increasing bus voltage. From base speed, the motor is accelerated to top speed by field weakening with bus voltage constant. The curves shown in Figure 17 illustrate this performance and are based on presetting the puller motor field

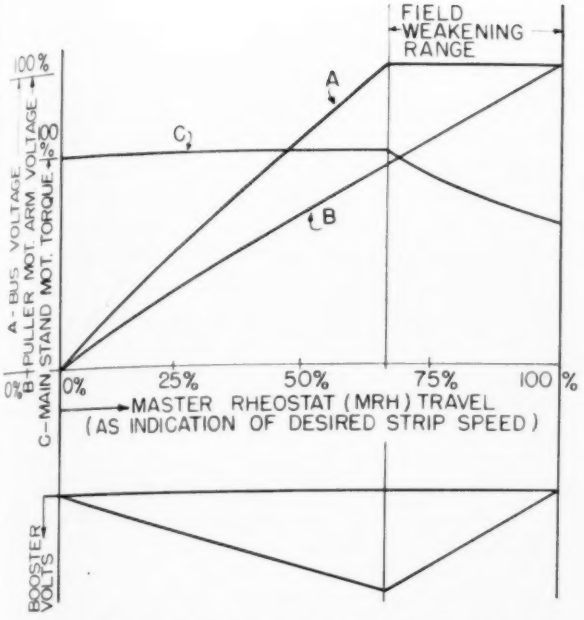

Figure 17 — Curve shows bus voltage, puller motor armature voltage, main stand motor torque, puller booster voltage vs master rheostat (MRH) travel.

Maximum booster voltage required to compensate for field range can be determined as follows. Strip speed at 600 volt on the bus and full field of the main stand drive motor is:

$$6000 \text{ fpm} \times \frac{(300 \text{ rpm})}{(478 \text{ rpm})} = 3765 \text{ fpm}$$

Puller motor speed (N) corresponding to a strip speed of 6000 fpm is:

$$N = \frac{\text{Strip speed}}{\text{Roll circumference}} \times \text{gear ratio}$$

$$N = \frac{6000}{21\ \pi/12} \times 1.0 = 1092 \text{ rpm}$$

Puller motor speed corresponding to a strip speed of 3765 fpm is:

$$\frac{3765 \text{ fpm}}{(21\ \pi/12)} \times 1.0 = 685 \text{ rpm}$$

Puller motor counter emf to obtain 699 rpm: (Neglecting effect of IR drop)

$$600 \text{ volt} \times \frac{(685 \text{ rpm})}{(1092 \text{ rpm})} = 377 \text{ volt}$$

Booster voltage component required to compensate for main drive motor field range is therefore 600 − 377 volt = 223 volt-bucking.

2. The voltage must be reduced by an amount equal to the armature IR drop of this generating puller drive. This is assumed to be 6 per cent or 36 volt-bucking.

3. It is assumed that the voltage across the line resistor providing a current signal to regulators will be 10 volt-bucking.

4. When smaller than normal work rolls are used in the pacing stand, strip speed and consequently puller voltage, must be lower for any given bus voltage. The booster must reduce puller armature voltage to obtain the proper speed by an amount proportional to change in roll size:

$$\text{Booster volts} = \frac{(48 - 44) \times 600 \text{ volt}}{48} =$$

50 volt-bucking

5. Variations between the field temperatures of the main stand drive and the puller motor result in variations in relative motor field strengths and hence speed. These variations must be compensated for by modifying armature voltage. The extent to which such variations affect booster size is primarily dependent on how the controls are adjusted during operation. For these calculations, assume the main stand motor field current is regulated to a constant value and the puller motor field circuit is adjusted at rated field current with a temperature of 75 C. The stronger motor field resulting when the temperature is at 25 C, will cause the motor to run slower. The armature voltage must then be increased to obtain proper speed. This required booster voltage component is in the reverse direction from that required to compensate for main stand field range and would not increase booster size.

The above does not apply to boosters used with reels. Since reel motor fields are automatically adjusted to regulate motor counter emf, any such tendency for speed error due to drifting of field strength will be automatically corrected by the counter emf regulator.

6. As a result of the draft taken in the mill, there will be a slight speed difference between its components. Each mill component should be considered separately to determine what this difference will be.

On a 2-stand mill with Stand No. 2 pacing the line and therefore establishing bus voltage, there would be essentially no speed difference between Stand No. 2 and the delivery puller. However, the speed difference between Stand No. 2 and the entry puller would be in proportion to the total reduction in the mill, probably a maximum of 5 per cent. This would require a maximum entry puller booster voltage component of 5 per cent x 600 volt = 30 volt-bucking.

7. Some mills, which have field operating range for both the main stand and the puller motors, utilize rheostat to program preset fields on these drive motors. These rheostat dials cannot be designed to give the exact field strength in all the drive motors for the same relative speed at any position of the rheostat. The resultant speed error must be corrected by modifying armature voltage with booster voltage. A 10-volt component of booster voltage should be adequate for this error. This is not a consideration in the example being illustrated since the puller has a fixed field and the main stand accelerates with programmed field weakening. Any possible error in rheostat design in this instance, such as weakening the main stand motor field before full bus voltage is attained, would only decrease booster capacity as required to compensate for the stand motor field range.

8. During periods of deceleration or acceleration, the entry puller motor current must increase or decrease by a value representing the required component of torque. The corresponding component of current results in an added IR voltage component which may dictate additional booster capacity. The worst condition for an entry puller would be during deceleration, where it is assumed

50 per cent load torque is required. This voltage component would then equal 50 per cent of the total component of Items 2 and 3.

When adding all of these requirements to obtain total booster capacity, it is necessary to decide carefully which applies to the particular component being considered and in what combination will maximum booster output occur.

For the entry puller being considered, all of these conditions could occur simultaneously and at a polarity such that they would all be additive:

1.	Required because of main stand field range	=	223 volt
2.	IR compensation	=	36 volt
3.	Line resistor drop	=	10 volt
4.	To compensate for small work rolls	=	50 volt
5.	Motor field temperature variations		No contribution
6.	Draft compensation		30 volt
7.	Rheostat tracking		Example does not require
8.	Inertia compensation		23 volt
	Total booster voltage required	=	372 volt

The booster generator voltage rating will thus be established at about 375 volt with a current rating equal to that of the puller motor.

Discussion

PRESENTED BY

ROBERT PEEPLES, Supervisory Engineer, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

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Robert Peeples: We note with interest that the power requirements of the temper mills shown on their illustrations are apparently quite recent, they seem to indicate the trends we see nowadays. We find most engineers are in better agreement on powers than we used to be.

We took our data and processed it in the same manner for temper mills, going back as far as 1937. We found some very great inconsistencies. Some of the older type temper mills apparently are doing a lot of business with little horsepower. We believe the modern trends better reflect all current factors plus a uniformity of practice.

On modern high-speed mills, it is our opinion that the separate generator scheme of support is the best. When all factors are considered, the efficient use of machines and the versatility are large factors in favor of the separate support. Cost wise, with higher horsepowers, there usually is not too much difference.

Control systems have become pretty much the same except in the matter of handling motor fields where some differences still exist.

A. F. Kenyon: Fundamentally the drive systems described by the authors are applicable to equipment supplied by different electrical manufacturers, although the detail working out of mechanical drive arrangements, power supply and circuit arrangements, regulating systems, etc., may vary considerably, and much room for argument is left on any particular project.

As has been stated by the authors, mechanical designs vary greatly from mill to mill, but the mill stands on many temper mills are the same heavy four-high stands that are used for tandem cold reduction mills. However on the last stand of a tandem cold reduction mill operating at say 6000 fpm, the drive motor will be of about 6000-hp rating, whereas on a tinplate temper pass mill also designed for 6000 fpm, the constant speed operation can easily be taken care of by a 1500-hp drive on Stand No. 2, and because of the interstand tension providing much of the power, only perhaps 750 hp on Stand No. 1. With essentially the same mill stand inertia, and drive motor capacities, only 15 to 25 per cent of a similar reduction mill stand, it is obvious that much slower acceleration and longer accelerating time must be tolerated on a temper pass mill than is usual on a tandem cold reduction mill. This has been very well covered by the authors, and accepted (grudgingly to be sure) by mill operators. Since the running load requirements are fairly low, the Stand No. 1 drive on many mills is smaller than on Stand No. 2, and with typical heavy four-high mill construction Stand No. 1 almost invariably is the most critical as regards acceleration.

Another allied operating problem is brought about by the relatively small mill stand drive capacity, particularly the No. 1 stand, and that is the matter of breakaway starting torque required to jog or start the mill stand after it has been stopped for more than half a minute or so with pressure on the screws. It is essential that the control include means to force the stand motor field to the maximum safe value in order to obtain the maximum possible field flux, and hence torque per armature ampere to meet this starting torque condition. On a mill recently put into operation, No. 1 stand starting currents up to 275 per cent of full load were observed and even this did not give the operators the starting performance they would like to have. It can be said that on almost any high-speed temper pass mill, the capacity of the No. 1 stand drive and to a slightly lesser degree the No. 2 stand drive, should be selected almost entirely by the breakaway starting and accelerating torque requirements rather than by the steady state running loads.

J. J. Remley: The breakaway starting torque problem must be given serious consideration in the selection of stand drive motor horsepower. The combined efforts of the mill builder and the electrical manufacturer are required to overcome it. Drive motors must be capable of delivering the required maximum torque.

One of the simplest ways to help solve this problem is to also recognize it as an operating problem. On a recent 6000-fpm temper mill, automatic timing circuits have been used to program the screws up and down. This relieves the roll pressure during the time the mill is stopped and the operators are getting the new coil ready for threading. Since this particular mill threads on the fly, the screws are brought down during the threading of the new coil with the stand motors turning over. This scheme works very well and no breakaway problems have been experienced.

Ten painting reminders for steel plants

. . . . Good results can be obtained from painting if the plant engineer will follow the ten common sense requirements outlined in this paper . . . .

by Walter T. Yarhouse,
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BEFORE beginning consideration of the ten painting reminders for steel plants, it is important that one realizes that "to paint or not to paint" is no longer the question. In this day and the forseeable future, one simply cannot afford not to paint. Most plant men have lived and probably will live a long time into the future with the knowledge that amortization of plant investments will produce a replacement fund far short of meeting today's and tomorrow's costs. Consequently, they are being pressured by economics to prolong the life of plant facilities to the greatest possible extent. Adequate maintenance is the obvious answer, not only for the structures that are worth saving, but especially those of more recent years when so many expansions added the newer more costly buildings to plant facilities. Their life expectancy must be assured, protected and prolonged as much as proper painting can perform this service.

The paint man has for years, literally been "a voice crying in the wilderness" in his efforts to induce the recognition of what paint can do to satisfy the needs for protection, preservation and decoration. Shortly before the War started was seen the dawn of an era of awareness to the need for proper cleaning, application, and conditions for obtaining from the maintenance painting dollar, the value available through the improvements paint research is constantly developing. Progress has been made whereby many concerns in many industries, including steel, have realized their maintenance painting is of such economic importance that it justifies the appointment of paint engineers or the employment of consultants whose experience warrants their cost, through the greater savings of property values they can make possible. We are gradually passing out of the dark ages when paint was something that came in a bucket and was swabbed on in an unsupervised fashion simply to make an improvement in appearance and gain some measure of protection.

Today, paint is being evaluated, judged and employed to the fullest extent of the qualities incorporated through the costly research and production efforts of the paint industry and the producers of its basic raw materials. Perhaps economic pressures have been a blessing in disguise. This progressive awareness has brought the Steel Structures Painting Council. Many words have been written on the subject of "maintenance painting in steel plants" and the best of them are contained in the two volumes published by the Steel Structures Painting Council, namely, Volume 1 of the Steel Structures Painting Manual, entitled "Good Painting Practice," and Volume 2, entitled "Systems and Specifications." Both should be in any plant reference library. The paper by Dr. Bigos (see 1957 Proceedings AISE) is typical of today's conception of the subject and the thoroughness with which it is being studied. Certainly, these have served to arouse, stimulate and sustain maintenance painting consciousness by the beneficial recommendations gained from the exhaustive considerations which have been made and are continuing.

It is realized that many factors influence the degree to which the results of these investigations and reports can be put into practice. Admittedly one may know what should be done but often cannot do because of limitations of money and time. Therefore, our conception in submitting the "Ten Painting 'Reminders' for Steel Plants" is tempered by the every day considerations which prevail.

These reminders are a consensus of the practical present day thinking of the maintenance painting engineer, plant maintenance supervisor, general maintenance foreman, consultant, contracting maintenance painter and the buyer of maintenance painting requirements.

Reminder No. 1—Supervision and Inspection (Probably the most important)—The first and ever so important reminder is "Supervision and Inspection." Too much maintenance money has been and is being spent without the safeguard of adequate attention to insure the economical and productive efficiency of maintenance painting operations. The paint supplier cannot be held responsible for his product if it is not used properly. So it is through adequate supervision of plant crews or

those of the painting contractor, that one will begin to realize the ultimate value in the maintenance painting dollars spent. Agreed upon inspection instructions and specifications for each stage of such work must be met to every practicable extent to insure the results for which one is spending company money.

Reminder No. 2—Cleaning—For reminder No. 2 we have "Cleaning." Here the "sins of omission and commission" are found out too late after the maintenance painting dollar has been spent. Rust, scale and other surface contaminants must be removed to the greatest possible degree commensurate with the expected performance of the protective coatings. Paints are designed to cope with residual rust to the best of available raw materials and formulation, but these can do only so much and the answer continues to lie in the effectiveness of thorough cleaning. There are no cost saving short cuts in cleaning.

Methods and means of cleaning constitute a considerable subject in itself. Time allotment does not permit more than a passing reference to it beyond the strong recommendation that one use the excellently detailed information given in Volume No. 1, "Good Painting Practice" of the Steel Structures Painting Manual. May we add however, that in our opinion the ultimate cleaning in the form of sand blast removal of all rust should be followed in conventional systems, by not one but two coats of priming type products to protect this more expensive cleaning investment. It makes sense to do this. The essence of the maintenance preservation lies in the continuing effectiveness of such priming which serves to anticipate delayed repainting schedules. This added factor can literally provide one with an extension of his lease on painting life. Such priming protection should, if possible, then be followed by two coats of finish type materials preferably in contrasting shades to insure proper application of the system and enable a dependable appraisal of wear during the maintenance inspections throughout the service life of the paint film.

Going beyond the systems of conventional materials to the new technical type coatings, while these may employ only one primer coat, their effectiveness is supported by measured minimum film thicknesses to assure a sufficient protection by the concluding finish coat application. Here we also find a still greater emphasis on surface preparation than with conventional coatings.

Remember that satisfactory cleaning by a simple wire brushing is often at a cost of four times that of the application of the paint materials when considering painting estimates or bids. It is a good practice to have such figures submitted to you on the basis of cleaning alone and painting alone, by which a more dependable decision can be made as to which estimate or bid offers the degree of workmanship you want to buy and by which, your painting dollar may or may not be, well spent. The quip about "the undertaker covering up the doctor's mistakes" applies just as readily to the painter covering his "errors of omission and commission" by which the finest paint formulations give only mediocre results while conversely, good cleaning followed by comparatively fair qualities can give substantially better results.

Reminder No. 3—Painting conditions—For reminder No. 3, we have "Painting Conditions." It is unfortunate, in the interests of good paint performance, that operating limitations in some areas of your plants do not allow for painting attention under ideal conditions. Therefore, such a handicap calls for the use of the most adaptable products and system, as well as a consideration that reasonable paint failures are not automatically reflected as a discredit on the products used. Often times, satisfactory performance under such conditions may be attributed to simple good luck. The paint manufacturer suffers loss of prestige and business thru unfair criticism under such circumstances.

"Painting Conditions" definitely calls for the inspection control referred to under Reminder No. 1—"Supervision and Inspection" as to whether the surface has been satisfactorily cleaned, whether temperatures are too low or too high, whether moisture conditions are present, or whether the season of the year is unfavorable to a satisfactory application of a successive number of coats.

Reminder No. 4—Thinning—Proceeding to Reminder No. 4 which has been identified as "Thinning," we have another point of importance under the responsibility of "Supervision and Inspection." The indiscriminate use of paint thinners or reducers is being curbed, but it continues either through ignorance or carelessness by the painter.

Using proper thinners to a controlled extent is becoming recognized through their necessity for the application of the newer technical coatings. No longer can the painter resort to gasoline or a cheap grade of naphtha or mineral spirits to thin out paint so it will go farther or apply more easily. When he does it without proper authority or supervision, he is inviting trouble—the buyer's trouble, later on. Percentages of reduction with the paint makers recommended thinner are a part of any paint specification and with a definite reason for each.

Uncontrolled thinning obviously undermines the quality performance of any paint. The effect of cold weather temperatures in raising viscosity of paints should be checked with the paint supplier for his recommendation before any thinning is done to ease application. The user wants all the "film build" the paint formulation provides.

Reminder No. 5—Application—"Application" is Reminder No. 5, with thoughts of brushing, spraying and rolling. Paints generally are supplied in a brushing consistency. This usually permits thinning a specified percentage to enable application by spraying. Roller applications require formulations assuring a necessary flow-out as well as film build. Economy-wise and considering all factors, spraying permits about five times the speed of application by brushing, while roller application is about three times the speed of brushing. In the latter case, roller application must be made with sufficient care to provide a uniform film.

Painting results are also affected by the quality and condition of the tools used in application. Worn-out and poor grades of brushes obviously cannot aid in the uniformity of paint films. The same applies to poorly adjusted or defective spray equipment.

When spraying, there are important considerations which begin with the correct air gap, fluid tip and needle, to assure proper atomization of the particular product at the designated atomizing air pressures. Painters universally are inclined to think that if they

have their air pressures high, they can spray faster and easier with satisfactory results. This is not true as excessive pressures mean excessive spray dust and often a much drier film than should be applied for the ultimate paint service. This is particularly the case with the fast drying technical coatings which many probably are using by this time. It follows that a spraying technique which applies full wet coats is important to the success of any job.

Before leaving Reminder No. 5, a comment regarding the brushing application of aluminum paints, is desirable. Most painters just do not know how or cannot be bothered to properly brush apply aluminum paints so that over-lapping will not show. The ability of the aluminum paint to perform satisfactorily is incorporated in the formulation, but misuse continues to give the poor results often seen. Aluminum paints should be "laid on," not brushed and rebrushed, and always from the unpainted surface into the wet coat.

Reminder No. 6—Film Thickness—Reminder No. 6, "Film Thickness" is becoming an everyday reference in the painting world. Here we see the importance of supervision deciding through the use of wet and dry film thickness gages whether the application of the paint coatings is being made to a sufficient extent. The convenient interchemical roll gage for wet films is suggested for constant control at time of application. With rough surfaces to contend with, it is important in this respect, that such readings be taken.

Paint films shrink on drying so a dry film reading is also desirable. Obviously, relying only on a dry film reading is not the answer as an insufficient film thickness then poses the problem of applying another coat with an added cost of application, or making a sacrifice in the ultimate paint service. There are convenient instruments for dry film measurements.

The necessity of film thickness control cannot be shrugged off any longer; or if so, at the user's expense, as it is now generally recognized that film thickness is a determining factor in obtaining the desired protection. Paint formulations today are providing a hiding power which makes the visual judgment of yesterday a fallacy. They give a visual appearance of a well covered job but no indication as to whether a sufficiently heavy coating has been applied. When in doubt, the paint supplier can readily inform you of the recommended film thickness of each coat. This is especially necessary where system applications of the new technical coatings depend upon definitely measured applications of minimum thicknesses.

Reminder No. 7—Specifications—Proceeding further, we now come to the materials themselves under Reminder No. 7, called "Specifications." To specify or not to specify raises a moot question worth examination. In using the term "Specifications," we apply it primarily to the school of thought which prefers to buy paints on formula specifications rather than by proprietary brand or performance requirements.

Some of the steel producers and other industrials, have reached the stage where they have established qualified paint engineers with testing facilities literally on a laboratory basis. In some cases, these engineers have established specifications of paint formulations based on their knowledge, test results and review with paint and raw material suppliers. Such information enables a quality determination with a rating of approved sources of the finished product, which in turn is used by their purchasing departments to buy as competitively as possible. While they depend on reliable sources to meet these specifications, samples taken at random are often examined to make certain all are living up to the letter of the specification. Affidavits of conformance are also in use.

Following such a policy and procedure obviously creates an assumption for the ultimate performance of the paint as it absolves the supplier of his usual responsibility, once the product has left his plant. It follows that such a practice may also develop into a static situation if the formulas are not reviewed regularly for revision to include the benefits of progress in paint formulations.

On the other hand, the policy may be to use approved proprietary brands selected through pretesting for competitive buying by the purchasing departments. This procedure brings the latest and best materials resulting from the paint suppliers constant research and improvement of his products. Such a policy appears to be preferable as the paint manufacturer's "know-how" is gained from his contacts and experiences throughout the iron and steel industry. This gives him a vastly greater knowledge for his paint improvements which places him in a superior position to serve requirements. The paint engineer's experienced selection and periodic evaluations then gain the best value for his company.

There is also the belief in certain quarters that specification control can be best exercised throughout "performance" specifications. These forego the formula specification, but make quality determinations by specific performance requirements a product must meet for quality for approval and purchase. Such a "performance" specification includes the details of application under stated conditions, drying, adhesion, flexibility, and minimum performance under specified exposures to the elements encountered in service. With no formula specified, qualified proprietary brand products can merit approval for competitive buying.

Let us also take advantage of the excellent references given in the Steel Structures Painting Manual, Volume 2, on "Systems and Specifications." It contains a wealth of helpful information resulting from practical experience.

While on the subject of "Specifications" perhaps some engineers have been somewhat confused by the references to the newer technical types of paint products introduced during the past few years. Paint suppliers and their literature refer to oil, alkyd, phenolic, chlorinated rubber, vinyl, epoxy, catalyzed epoxys and combinations with modifications to the point where one may not know which is the type best suited for a specific requirement. The 1957 Proceedings AISE includes Dr. Bigos' "Evaluation and Specification of Paint for Industrial Use," Table 2 of "Comparative Resistant Values of Typical Commercial Coating Formulations." This may be supplemented to advantage, with the "Selection Guide for Metal Protective Coatings" given in Table I. This "Selection Guide" was developed by a major paint manufacturer and offers the current thinking which may be helpful in discussions with paint sources.

Reminder No. 8—Standardization and Records—Reminder No. 8 deals with "Standardization and Records"

which are also important in today's dealings with painting in steel plants. Control requires the standardized use of materials, systems and colors for specific surfaces and areas. Haphazard use of paint products reflects a lack of control with consequent costly maintenance painting habits.

Many companies have developed standardization manuals suited to their conception of their requirements. These show a varying extent of detail regarding the treatment of individual surfaces and plant buildings as subjected to different exposures in areas of operation. If one should be considering such a reference to cover his responsibilities, this can begin with a simple color chart indicating products and the surfaces upon which they are to be used. It in turn can be expanded to an elaborate detailing of properties with a system of painting old and new surfaces both interior and exterior of each building. These may then be cataloged with exposure area captions such as *Normal, Moisture, Abrasive, Acid —fumes or solution, and Heat.* Whatever one does, it has been found desirable to keep the details to a minimum to avoid confusion and encourage usage.

D. E. Whitehead, chairman of the AISE Paint Committee advocates a simple basic color system, using possibly the Federal Color Standards with a class reference. This will range from structures which lend themselves to color, through location and exposure.

Included with the subject of "Standardization" is also the need for adequate "Records." Such records should provide the details of every painting operation. They should include date of application, application conditions, method and degree of cleaning, method of application of primers and finish coats, who did the work, and who supplied the materials. Such data along with all cost information, gives a finger-tip reference for the evaluation of services and a true reading on each job. Data such as this is most helpful when setting-up maintenance budgets as they would include labor and quantities of materials used. Periodic comparisons of performance ratings will readily indicate the degree with which each is serving your interest in economy. Keeping records and using them efficiently is not a necessary nuisance but a credit to your conception of the ultimate accomplishment.

It follows that comparable records of all test applications are also valuable and necessary to your progressive evaluation of paint products and systems. Tests, whether by means of panel exposures, patch applications directly to the surfaces involved, or total surfaces, do not fulfill their purpose unless properly recorded with all details at time of application and during periodic examinations prior to a conclusion.

Reminder No. 9—Buying of materials and services—Reminder No. 9, "Buying of Materials and Services" is purposely included to focus attention on the shortcomings one sees and hears of so often, whether it involves materials, contracting services, or both. Let us assume a case where it is a question of buying the paint and buying the services of a painting contractor. Shall we do it the easy way and let the contractor select and buy the paint along with supplying his services? This is a practice that is still done. Shall we specify the paint the contractor is to buy and apply? Or, shall we buy the paint ourselves and contract his labor and equipment?

With this in mind, we must remember the contractor is in business to make money. He is not experienced in the selection of paints or systems, nor will he apply any more paint than is necessary to "get by" on the job. Although he is considered responsible, any failure of paint of his selection, allows for the possibility that he in turn will consider the paint supplier the responsible party. The result is a debate to a point where you in all probability will assume the eventual cost of correction, inasmuch as the paint supplier feels his product was "right" when it left his plant and so cannot be held accountable for poor results through mis-use or abuse. From this, it is obvious that the practice of allowing the contractor to use materials of his choosing, or even his buying of paint by your specification, leaves room for doubt. So there are these objectionable aspects, which even with reasonably good supervision, leaves too much margin for possible dissatisfaction.

Assuming that the plant will buy the paint and hire the contractor's services, the price paid for the paint under the quantities and specifications issued, raises a question. We well know that one gets only what he pays for as the word bargain is subject to definition. Paints of equivalent quality should prove competitively priced within a few cents of each other depending on the price policies of suppliers and freight costs. Therefore, having the accredited materials from which the buyer may choose, based on ratings given him from the standpoint of ease of application, spreading rate, etc., the decision as to who will supply the paint is a simple one.

At this point, let us consider another factor which occurs when buying on a formula specification. Instances are heard of regularly where competitive buying has reduced prices to the point where the paint manufacturer is on the "ragged edge" of complying with a formulation in his endeavor for the lowest cost to enable him to participate in your business. As can be seen, this reaches a "point of no return" as he tends to sacrifice under pressure, the "plus factors" which make quite a difference in the handling of paint materials. He may resort to a coarser grind and he may sacrifice ease of application, which add up to poor handling and reduced spreading rate at the time of application. Therefore, it is to the plant's advantage not to squeeze the very last cent out of every paint price. Repeating again, one will get just what you pay for and nothing more.

Since the plant is buying the paint, the contractor is then asked to bid on the work. The usual routine is to simply take the low bid for the job. There is quite a fallacy in such a decision and it goes far in reducing the value received for the money spent. Specifications should be written to include the time schedule to be met, the degree of cleaning required, the system of painting to be followed, the film thicknesses required, method of application, drying time between coats, temperature and weather conditions, along with the usual protective features regarding insurance, performance bond, labor requirements, safety rules, etc., as normally practiced in the plant's location. With this should be the information that the plant will delegate the acceptance of all stages of the work, as well as final acceptance, to authorized supervisory personnel. Making these stipulations clearly understood at the outset, precludes later difficulties in the interpretation of performance as the job progresses.

Inasmuch as proper cleaning is so important and realizing that the labor of simple cleaning by wire brush-

TABLE 1
Selection Guide. . . .Metal Protective Coatings

Conditions to be met	Oil modified alkyd	Epoxy ester	Chlorinated rubber	Polyvinyl chloride	Catalyzed epoxy
Normal exterior exposure	Good 1*	Good 2	Good 3	Good 1	Good 2
Maximum Temperature in service	200 F.	250 F.	150 F.	150 F.	350 F.
Water immersion at normal temperature	Not recommended	Not recommended	Good 1	Good 2 (5 mils minimum film thickness)	Not recommended
Soap—6 hr contact	Not recommended	No effect	No effect	No effect	No effect
Ammonia vapor, concentrated—4 hr	Not recommended	No effect	No effect	No effect	No effect
Caustic soda, 5 per cent	Not recommended	Slight blister at 3 hr	No effect 168 hr	No effect 168 hr	No effect 168 hr
Hydrochloric acid, 10 per cent	Not recommended	Slight blister at 18 hr	No effect 168 hr	No effect 168 hr	No effect 168 hr
Sulphuric acid, 50 per cent	Not recommended	No effect 72 hr; slight discoloration at 100 hr	No effect 168 hr	No effect 168 hr	No effect 168 hr
Sulphur dioxide, concentrated vapor—4 hr	No effect	No effect	No effect	No effect	No effect
Hydrogen sulphide fumes—24 hr	Discolored	Very slight discoloration	No effect	No effect	No effect
Bromine vapor, concentrated—24 hr	No effect	No effect	No effect	No effect	No effect
Petroleum oils and solvents	Not recommended	Good 3	Fair	Good 2	Good 1
Xylene	Not recommended	Not recommended	Not recommended	Fair	Good
Neutral salts, e.g., calcium chloride and sodium chloride	Good 3	Good 2	Good 1	Good 1	Good 1
Animal oils and fats	Good 2	Good 2	Not recommended	Good 2	Good 1
Strong oxidizing acids—sulphuric acid and nitric acid	Not recommended	Not recommended	Fair 1	Fair 2	Fair 2
Minimum surface preparation	Hand cleaning	Hand cleaning	Hand cleaning	Complete rust removal	Complete rust removal
Ease of application	1	2	3	4	5
Average dry film thickness per coat (mils):					
Primer	1.5	1.4	1.0	0.4	1.5
Top coat	1.6	1.4	1.0	0.7	1.5
Application					
Preferred	Brush	Brush	Spray	Spray	Spray or Roller
Alternate	Spray or roller	Spray or roller	Brush	....	Brush

*1, best; 2, next best, etc.

ing can easily average four to five times that of the paint application, it behooves one in his interests to specify that contracts must be bid, showing a breakdown of labor for cleaning, and the labor for painting. Having this comparative information then simplifies the final judgment of which bid is the best for the job. Naturally, the contractor's reputation for getting jobs done on schedule, his co-operation in performing his work as specified, and general all around workmanship, have an influence in the matter.

Low bids invite short cuts in labor time with resultant compromises in cleaning, number of coats applied, application under unfavorable conditions, and a variety of other abuses. As we said before the contractor is in business to make money.

The "Supervision and Inspection" emphasized as Reminder No. 1 is all important to the plant, and its cost is well worth considering as a form of job insurance. Painting is done on confidence, but in the hands of unprincipled operators, it can readily become a "confidence game."

These comments have gone to a considerable length on this subject as it is surprising at how often the placement of painting contracts is handled in a casual manner by men who know better, but do not do better. There is always the question whether the buyer, who is quite remote from the scene of the actual work, and judges a job only by the figures on paper, is in a position to exercise the judgment necessary to the long range interests involved. The low bid is often the poorest and it may be to the plant's ultimate advantage to favor the man whose bid is in the middle, if not occasionally on the top of the list. It is good business for the buyer to consult with the paint engineer before making an award.

Reminder No. 10—Color—The final Reminder No. 10 has to do with the growing use of "color" in steel plants. While the use of color has been advancing in all fields since the end of the War, the problem of dirt conditions in iron and steel plants is a continuing hindrance. However, the psychological influence of color is recognized and cannot be disregarded. Color belongs in the "clean" areas of iron and steel operations.

Machine shops and other "clean" departments are reflecting a pride in appearance and good housekeeping wherever "color" has been initiated. Who enjoys or does his best work in dingy surroundings? Whether one consciously realizes it or not, it means much to morale, interest, job contentment, and a consequent reduction in sub-standard work.

Safety colors are of course a "must" in all plants. Red, Safety Green, Hi-Visibility Yellow, Alert Orange, Precaution Blue, and Purple serve their designated pur-

poses. Light colors used on storage tanks of volatile solvents prove a good investment in the reduction of evaporation losses.

There is thinking in some quarters which favors a departure from aluminum paint for interior surfaces because it tends to lose its initial brightness and light reflection value in a relatively short time, and because of its tendency to collect dirt more rapidly than the smoother enamel type finishes. Enamels, preferably in the semi-gloss effect, have an advantage. They hold their color character much longer and so have a much better appearance retention. There is the matter of choice between the aluminum with its excellent one coat hiding at a lower cost per gallon, and a one spray coat of a light gray shade at a cost not sufficiently higher to make it prohibitive. As an interesting sidelight to the consideration of the effect of color and dirt on light reflection value, comparative tests have shown that a white, with its superiority, after it has been in service for a whole year, still shows an equivalent light reflection value to a light gray or aluminum which have been freshly applied. In other words, white provides an added year of maximum light reflection value before it begins to show a diminishing due to normal dirt accumulation.

As a final word on the subject of color, major paint sources are experienced in dealing with color treatments. Their assistance is available for the asking if they have not already persuaded plant men to use the advantages "color" offers in operations.

Before concluding these "Ten Painting Reminders for Steel Plants," we should like to add a feature which may be helpful at times. In the Appendix is reference information entitled "Common Finishing Troubles, their appearance, their causes, and their corrections." This reference enables an "on the job" diagnosis of paint difficulties which often have a simple solution and so do not require a delay until a service call can be made by the paint supplier.

We would be remiss in this article if we did not touch on the prospects of further paint improvements which today's research will make available tomorrow. Acceptance of newer coatings is an encouragement to the men who research, make, and sell the latest thinking in paint coatings. Soon we may hear of coatings which will carry generic identifications such as polycarbonates, polyurethane, chloro-sulphonated-polyethylenes, and fluorinated hydrocarbons. Presently, these are being thought of in conjunction with the severe corrosive problems encountered in chemical plants. However, their introduction in a practical way, will no doubt result in adaptations to requirements wherever they can give you improved protection. Whatever they may be, they will have value and will be worth trying and buying them.

Finally, this article is simply a case of reminding one of the important considerations which must be in constant practice to achieve the greatest economy in "painting in steel plants for protection and preservation." It is unfortunate that the pressure of business often limits one in employing the best practices, so that while one may know better, he often cannot do better. However, the general level of maintenance practices is improving as those in authority give increasing recognition to the important role paint engineers play in the profitable operation of their plants.

Remember:

1. Supervision and inspection.
2. Cleaning.
3. Painting conditions.
4. Thinning.
5. Application.
6. Film thickness.
7. Specifications.
8. Standardization and records.
9. Buying of materials and services.
10. Color.

The AISE Paint Committee has a wealth of practical and proven recommendations available for assistance. The two Volumes of the Steel Structures Painting Council are known. With these plant men have the individual co-operation of the paint supplier who is at his service to the best of his ability.

APPENDIX

COMMON FINISHING TROUBLES APPEARANCE—CAUSES—CORRECTIONS

1. *Lack of hiding*

Cause	*Remedy*
A. Over-reduction.	A. Add fresh, unreduced material to that which has been reduced.
B. Application on very cold, smooth surface which tends to cause film to flow off.	B. Use a faster evaporating solvent.
C. Pigment not properly stirred into suspension.	C. Agitate thoroughly.
D. Too slow evaporating solvent causing too much flow.	D. Use faster solvent.
E. Improper atomization.	E. Adjust spray equipment or may require additional thinner especially when material is cold.

2. *Sagging of film (curtaining)*

Cause	*Remedy*
A. Sagging is caused either by over-reduction or by use of too slow a solvent.	A. Use the proper solvent consistent with the general nature and temperature of the surface to be coated.
B. Application of too heavy a coat.	B. Apply thinner film.
C. Second coat applied too soon.	C. Lengthen drying time between coats.
D. Draft condition.	D. Eliminate draft.
E. Strong sunlight causing top drying and consequent later slippage of film on vertical surfaces.	E. Avoid application in strong sunlight.
F. Uneven distribution of spray coating.	F. Apply more uniform coats of material.

3. *Crawling and pinholing*

Cause	*Remedy*
A. Presence of condensation or moisture on the surface.	A. Be sure surface is thoroughly dry.
B. Foreign substances such as grease or oil on the surface.	B. Thorough cleaning of surface is necessary.
C. Too much gloss of undercoat plus low temperature of surface.	C. Moss down and/or wipe off with turpentine or other solvent cleaner.
D. Incompatibility of undercoat and finish coat.	D. Use materials of correct balance.

4. *Lack of adhesion*

Cause	*Remedy*
A. See "Blistering."	A. See "Blistering."
B. Certain types of metal such as galvanized iron, cadmium, zinc, are difficult surfaces.	B. If normal methods of metal preparation do not overcome adhesion difficulties, then send full particulars, along with samples of metal to your supplier.
C. Unclean surface.	C. Clean carefully with volatile solvent, or if metal, with a commercial metal chemical cleaner.
D. Lack of film toughness, produced by over-addition of drier.	D. Check results against fresh material to which no drier has been added.
E. Sometimes the finish coat and the primer used are not meant to be used together, and the solvent in the finish coat practically lifts the primer from the surface. Even though film will dry and have good appearance, primary adhesion has been ruined.	E. Make sure that the proper recommended primer and finish coat are used together.
F. Condensation of moisture on the surface.	F. Be sure surface is thoroughly dry before applying any finishes.

5. *Lack of adhesion between coats*

Cause	*Remedy*
A. Primer and enamel not recommended for use together.	A. Use properly recommended system.
B. Primer dries too hard either due to inherent drying quality or long aging prior to application of finish coat.	B. Roughen primer with sandpaper or steel wool. It may even be necessary to use a reducer of higher solvent strength in the finish coat in order that a tooth can be obtained in the primer film.
C. Presence of foreign substances.	C. Clean surfaces thoroughly before application of paints. Surface must be thoroughly dry and free from condensation.

6. *Excessive body*

Cause	*Remedy*
A. Any material which will dry in the presence of air at normal temperatures will tend to take on body by virtue of the oxidation which takes place.	A. If bodying of the material has not proceeded to the point where there is livering action, it is often possible to bring the thickened particles back into solution by addition of a stronger solvent from the same solvent classification.
B. In the more advanced stages of oxidation, a livering action often occurs which is aggravated by the too swift addition of extra thinner. It should be added slowly and the mixture stirred at the same time.	B. If a definite livering has occurred, it is not easily feasible to reclaim the material.
C. Use of improper solvent.	C. Use recommended thinner.

General: The primary cause of excessive bodying is, in most cases, improper handling of storage facilities. Maintain normal temperatures for materials held in storage. Keep containers tightly sealed.

7. *Blistering—steel*

Cause	*Remedy*
A. Contamination in the prime coat such as water, oil, glycerine or alcohol in air lines.	A. Check air lines and clean out.
B. Dirty surface such as grease and scale.	B. Check the cleaning operation.
C. Cleaner entrapped under scale.	C. Be sure no moisture is entrapped under mill scale and steel is dry.
D. Moisture on surface.	D. Surface must be thoroughly dry before applying finishes.

8. *Blistering—wood*

Cause	*Remedy*
A. Moisture in wood.	A. Wood should be dry before painting. Check change in relative humidity with nearest weather bureau.

9. *Excessive chalking*

Cause	*Remedy*
A. Finish coat applied over porous surface which absorbs the binder and leaves unprotected pigment at surface.	A. Seal porous surface thoroughly before application of finish coat.

10. *Cracking or crazing of film*

Cause	*Remedy*
A. Application of hard drying material over a very long oil undercoat.	A. Make sure that materials used comprise a definite approved system.
B. Application over unsatisfactory short undercoat.	B. Be sure materials are of compatible length.
C. Application of too heavy coats.	C. Apply only sufficient material to accomplish full covering.
D. Undercoat has excessive gloss.	D. Moss or sand down to reduce gloss.
E. Excessive gloss of finishing material when one coat is applied over another.	E. Moss or sand down between coats to reduce gloss.
F. Improper drying of undercoaters prior to application of succeeding coats.	F. Be sure surface is thoroughly dry before application of succeeding coats.

11. *Poor or nondrying*

Cause	*Remedy*
A. Cold weather.	A. Maintain a temperature of at least 65 to 75 F for normal drying. Thin paint with proper thinner and apply thinner coats.
B. Absorption of drier by paint material.	B. While it is a problem of formulation to avoid possibility of drier absorption, there are occasions when the best formulated products are apt to face that difficulty. Remedy is to add up to 3 per cent of the proper drier.
C. Greasy, waxy, or otherwise unclean paint surface.	C. Clean surface carefully with volatile solvents or chemical cleaner.
D. Failure to stir all pigment of pigmented finishes into proper suspension before application. Failure to stir properly unbalances formula of applied material and often will cause poor drying.	D. Stir it.
E. Improper ventilation.	E. Provide ventilation.
F. An attempt to fill rough wood or metal by applying a heavy coat retards through drying.	F. Do not attempt to use finish coat as a surfacer. Apply only a full covering coat.
G. Condensation of moisture on surface.	G. Be sure surface is dry. Maintain uniform temperature of surface with shop temperature.

12. *Laps*

Cause	*Remedy*
A. Material being applied too dry.	A. Apply wetter coat by: 1. Working closer to job. 2. Thinning material out to satisfactory spraying consistency. 3. Maintain a wet edge.

13. *Streakiness, gloss and dull spots*

Cause	*Remedy*
A. Improper or improperly adjusted spray equipment.	A. Be sure equipment is suitable for type of material being sprayed, and if so, that it is clean and properly adjusted.
B. Material not sufficiently thin.	B. Material must be sufficiently thin to handle well with available equipment.
C. Non-uniformity of application.	C. Apply full, even coats. Apply alternately cross-wise and length-wise surface.

NOTE: See "Flat Spots" also.

14. *Flat spots*

Cause	*Remedy*
A. An absorbant undercoat has not been sealed in and, accordingly, causes top coat to strike in.	A. Seal the surface.
B. There may be chemical substances upon	B. Make sure that surface is carefully

the surface which would tend to dull the gloss.	cleaned before finishing. In case of fumes attacking film, remove the source of fumes from close contact, if possible.
C. Slight wrinkle in spots.	C. Use less drier.
D. Oily or dirty surface.	D. Provide clean painting surface.
E. Generally caused by high humidity and damp cold weather.	E.
F. Improper spraying (this and many spots or dust from overspray).	F. Do better job of spraying. Maintain a wet edge.
G. Water or condensation of moisture on surface.	G. Dry surface thoroughly before painting.
H. Grease on surface.	H. Check cleaning.
I. Painting over frost early in morning.	I. Be sure any moisture on surface has dried thoroughly.

15. *Dusty appearance*

Cause	*Remedy*
A. Too fast drying thinner.	A. Use slower drying thinner. Apply a wet coat.
B. Too high nozzle pressure.	B. Nozzle pressure should not exceed 80 to 90 psi.
C. Overspray.	C. Mask where possible.

16. *Excessive spray dust*

Cause	*Remedy*
A. Wrong solvent blend.	A. Usual remedy is to choose a slower evaporating thinner.
B. Excess spray pressure	B. Reduce pressure.
C. Holding spray gun too far from surface.	C. Move gun closer to surface.

17. *Excessive settling*

Cause	*Remedy*
A. Over-reduction or improper thinner.	A. Follow thinning instructions.
B. Too rapid addition of thinner, causing break.	B. Add thinner gradually, stirring constantly.

18. *Breaking of liquid*

Cause	*Remedy*
NOTE: If the break is too pronounced, it may not be possible to put the material back into condition satisfactory for use.	
A. Wrong solvent used.	A. If the break is slight, the slow addition of the proper solvent, along with constant agitation, may effect a good result.
B. Subjected to unusual conditions of heat or cold.	B. Keep material at a temperature from 70 to 75 F. If break occurs because of extreme of either heat or cold, the treatment is similar to correction E.
C. Over-reduction.	C. Follow directions for proper reduction. If material already over-reduced, addition of fresh material will often bring entire batch back to proper state.
D. Reducer added too fast without sufficient stirring.	D. Add reducer slowly stirring constantly.
E. Natural oxidation of the material, if allowed to remain open to the air over a period of time.	E. Addition of proper amounts of solvent plus infusion of fresh material will put batch into condition if oxidation has not proceeded too far. It is usually well to choose a reducer of greater solvent strength than originally recommended.

19. *Skinning of liquid*

Cause	*Remedy*
A. While it has been possible to a large extent to minimize skinning, it is something which will occur to a varied degree whenever any air drying enamel is exposed to the air.	A. Make sure that containers in which the material is stored are air tight. Whenever conditions are such that skinning cannot be overcome by a normal means, advise supplier.

20. *Brittleness*

Cause	*Remedy*
A. It is often difficult to differentiate between "lack of adhesion" and "brittleness" in evaluating some film failures. Other than inherent brittleness or lack of adhesion in a finish, the cause for such complaint will be the same.	A. See "Lack of Adhesion."

21. *Bleeding*

Cause	*Remedy*
A. Organic red pigments	A. Best remedy is to

	or various dyes used in stain or undercoats have not been sealed properly.	avoid use of bleeding colors. Where bleeding colors have been used, a shellac type sealer usually tends to seal the bleeding better than varnish or lacquer type sealers.

22. *White spots*

Cause	*Remedy*
A. Water coming through separator or by not having the surface dry.	A. Clean air line and separator. Be sure surface to be finished is dry.

23. *Brown spots*

Cause	*Remedy*
A. Oil coming through separator.	A. Cleanliness.

24. *Pinholes or bubbling*

Cause	*Remedy*
A. Drafts which cause surface drying and force the solvent to break that surface film in order to evaporate.	A. Avoid drafts.
B. Fine drops of moisture coming through separator in spray apparatus.	B. Clean spraying equipment.
C. In the case of wood finishing, either the solid wood or the veneer may be improperly kiln dried.	C. Only solution is to cure wood properly.
D. Thinner evaporates too fast.	D. Use slower thinner.
E. Porous surface.	E. Use sealer before applying finish coat.
F. Incomplete drying undercoat. Strong solvent in finishing coat tends to react with undried undercoat.	F. Use a faster drying undercoat or allow greater drying time.
G. Spots of grease on surface.	G. Clean surface carefully.
H. Material applied while frothy, following violent agitation.	H. Allow froth to subside before application.

Discussion

PRESENTED BY

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Dr. Joseph Bigos: The thing that struck me, in listening to the paper more than anything, was the simple, concise approach to the painting problem. This is refreshing and it is something to think about.

I do not want to discuss any of the technical aspects of painting; I do want to discuss this phase of the paper. Every man here can be his own paint expert—the problem is that fundamental and that simple, and the know-how is here. Ninety to 95 per cent of the painting that is done in iron and steel plants is conventional type painting, and for this we have economical and attractive solutions today. Every man today has the facilities available to study the fundamental aspects of that problem very easily. Much of the information is given in Mr. Yarhouse's paper. He has described the guiding principles; anyone can easily follow those and come up with a good painting program, or a good painting job for a plant.

When we get to the five or ten per cent of the area that does require specialized knowledge of painting, then we do call in the so-called experts. He may be an expert to you, but to himself he is just a gambler, or stumbling around in the dark. When you do get to the technical problem which you cannot master yourself, then I suggest that you call in the paint representative. The paint representatives are of two types. All of the better paint companies have technical representatives who are very happy to service the paints that you buy. In fact, that is the main justification for using such paint, as far as I can see—the service that goes along with it. You should avail yourself of that technical service because you are paying for it.

These men will be very happy to come in and work with you on any difficulties of application, surface preparation, or solving a particularly difficult problem which requires a specialized system which may have to be designed for the particular application; or which utilizes a new type of material which is unfamiliar to your painters, or perhaps even the contractor that is going to do the work.

Call in these men who are the representatives of competent paint companies, because you can tell from the answers they give you whether they are qualified. If the man tells you that he has a paint that you can put over rusty steel without surface preparation, or that you can eliminate surface preparation—do not spend a nickel calling him again, because he is out to sell paint and nothing else.

There is not a single technical representative of a reputable paint company in the country that I know of—or in the world—that will not fail to stress the importance of adequate surface preparation and application. He will not push any miraculous product that he

has which eliminates the necessity for doing a good job in the application and surfacing—or a paint which will spread at fantastic coverages and protect at a very low cost figure.

I do want to emphasize that every man has the ability to master the painting program, or the painting problem because it is that simple—there is no need for experts for good painting—the fundamentals are well known and they are easy to exercise. But if you do get in over your head, then call in the technical representatives who are more than happy to help.

C. K. Johnston: The "Ten Painting 'Reminders' for Steel Plants" are the most important factors to consider in applying protective coatings in any type of industry. They are, indeed, universal in their application.

The more corrosive an industrial atmosphere is, the greater the challenge to any protective coating system. Without utilization and enforcement of all of the ten points covered by Mr. Yarhouse, most paint applications would terminate in premature failure. Vinyl resin paint, one of the new technical types of paint products mentioned by Mr. Yarhouse, requires a greater degree of enforcement of the ten points than other types of slower drying paints.

I have found that it is quite necessary to provide a paint inspector on each major painting job in order to obtain a maximum degree of adherence to a painting specification. Few painters realize the great importance of properly cleaning the surface and application of coatings to uniform film thickness and tend to pay too little attention to these and other details unless they know an inspector is going to check their work closely.

Sandblasting to bare metal has proven to be standard practice in most industries where severe corrosion has taken place, or where the paint system or type of paint is going to be changed.

In areas where repainting is required, and there are large areas of good paint left, commercial sandblasting can be permitted with good results. In this way the entire surface is cleaned of all contaminants, all rusted areas are cleaned to bare steel, but tightly adhering paint is not completely removed.

In most industrial areas, conditions are far from ideal for the application of paint. Therefore, one important point to remember is that painting over sandblasted surfaces must be done immediately to prevent recontamination of the clean surface by atmospherically-suspended particles.

Dr. Joseph Bigos has said, "Every painter thinks he is an expert at thinning paints." Synthetic resinous paints, such as the vinyls, epoxys and chlorinated rubber, etc., are particularly critical to thinning. Use of an incorrect thinner may cause the paint to be converted into a gelatin-type material and become useless as a paint.

A great proportion of all industrial paint is now applied by the air-spray method. I have found that when properly done, spray painting is both superior to and less expensive than brush painting. However, correct techniques must be developed and used for each general classification of paint used. The same technique used for spraying slow-drying oil paints cannot be used when synthetic resin paints are used.

Synthetic resin paints, such as vinyl, require more thorough care in seeing that the fluid and atomization pressure is kept to a practical minimum. The working distance from the surface to the nozzle of the spray gun must be kept uniform to allow a uniform wet-film thickness of paint to be deposited on the surfaces being painted. Working distances and keeping the spray stream perpendicular to the surface are extremely important at all times to insure a satisfactory coating thickness and finish.

It is becoming increasingly important that painting specifications be written more specifically to cover adequately surface preparation, application technique, and film thickness required for each type of paint used, if a satisfactory job is to be attained. General specifications, loosely written, usually result in inadequate application, particularly when synthetic resin paints are to be used.

Because of the fact that so little definite information is known about the performance of various types of paints in various types of exposure, most industries carry on some type of paint testing program. In most cases painted test panels are used to compare one coating with another in order to discard those paints which do not meet a minimum performance standard. As new paint formulations arrive on the market, these are placed in competition with those already in use.

By this testing program, much has been learned by both the user and manufacturer of coatings, the results of which have benefited both of them. Invaluable data has been accumulated over the life-span of coatings tested and thus serve as a guide for future applications.

I believe that by the use of newer paints now available, applied in the correct way, on properly prepared surfaces, a great reduction can be made on the gigantic yearly painting bill now being paid by industry. Mr. Yarhouse's ten points, if followed, will aid all of us in reaching this goal.

J. H. Dillon: It was also very gratifying to see that Mr. Yarhouse realizes that we have limitations in the execution of any painting program. I know that is true with us, and probably very true for others. We have limitations of budget, time, manpower, operating conditions and other factors. All these things combine to make an intelligent painting program sometimes difficult to arrive at.

It is those very limitations that lead me to ask a question of Mr. Yarhouse. I will ask a question by hypothecating a situation wherein a given plant has various painting requirements or painting needs—various in the sense that they range from the ideal maintenance program, wherein painting is done when the need first arises, when the existing paint film begins to break down, to the need where the structure has long been neglected, where corrosion has progressed to a very great degree—perhaps in places where the metal loss is 100 per cent or approaching it. Suppose that we have limitations that prevent us from doing more than approximately 50 per cent of the required jobs. Now, I would ask Mr. Yarhouse upon which of those jobs he would put the emphasis with a view to long-range and over-all economy. Should we concentrate on the ideal maintenance, or should we concentrate on the commonly called more critical problems?

There is another aspect of painting and I would like

very briefly to mention it—I believe it is related to specifications as much as anything. That is the determination of exposure conditions. It is obvious that we cannot prescribe for those situations unless we know very definitely what the situations are. There is every evidence that conditions are not adequately evaluated in advance of the painting project.

This might lead me to a little bit of conflict with Dr. Bigos who stated, I believe, that 99 per cent of mill painting was normal. I believe in many cases the mill building, although commonly called a normal exposure, is subject to exposures other than normal. We see proof of this in premature paint failure which is commonly ascribed to a variety of reasons. I am not going to mention all of those things, but a few of them are these: the common practice of protecting an area immediately over a furnace is well known, but generally neglected are the adjacent areas which may be more subject to an abnormal or severe exposure than those immediately over the furnace.

Another very simple case is that of column bases which, by their very nature, are exposed to severe mechanical damage and natural spoilage. We find an almost universal practice of treating these column bases the same as we treat the upper shaft of the column, etc.

It is in this recognition—the evaluation or identification of actual or potential hazard that I believe our greatest opportunity lies for improving paint protection experience. Now I am talking particularly about mill projects; mill construction. If we can recognize the exposures, it is my belief that there are products on the market today that will adequately protect against nearly all such exposures—but they do have to be recognized and evaluated. If we do that—if we get the proper initial protection, it is comparatively easy to maintain a structure. If, on the other hand, the exposure is not recognized at the beginning, we have premature paint failures and usually we have continuing corrosion, loss of metal and all the attendant by-products of such a situation. In such a case, maintenance becomes pretty much a losing, and hopeless, proposition. We try—we do some good. But quite often, we are only improving the appearance; we are not doing too much toward the solving of the actual problem.

There is another aspect in maintenance painting, and that is the recognition of the causes of paint failure. Too many times, I believe, paint inspection simply consists of looking at a structure and saying, "Well, it needs paint," and then the procedure is to apply the same painting program as was originally applied.

Now there are many causes of paint failure—such things as poor application, chemical failure, and so on. I also believe that this is extremely important in any maintenance painting program—that the cause of the failure be definitely identified and intelligent action taken to provide a system of paint and paint application that will be capable of combatting these particular spoilage conditions.

R. E. Gwyther: Before going into the questions, I would like to point out that I worked with Mr. Yarhouse in the preparation of his paper. In our discussions at that time, we decided that what he could say would necessarily have to be somewhat general, since your interests in paint are so widely varied. Hence, we thought that to orient you on the over-all picture would be most in order.

We should all realize that a straightforward approach to the problems of corrosion control is possible. This is not a complicated issue, except, perhaps, in less than five per cent of your areas. It is not difficult to solve the problems, provided only that capable people with the proper perspective and proper authority to apply the results of experiment take over the work.

Mr. Johnston has given us some very worthwhile information, all of which I think is completely accurate. We recognize that vinyls and some of the newer coatings require more careful surface preparation than do the older, conventional paints. This only emphasizes the necessity for close inspection of every phase of paint application.

Mr. Dillon has raised a very perplexing question: where to use maintenance money? Should you put it into spot repairs in those areas which show normal corrosion; or spend the money to rehabilitate a plant that is badly corroded?

I contend you cannot ignore either of these areas.

If you do not spot repair areas of normal corrosion at the time such repair is indicated, you will be in trouble later when corrosion has become serious. On the other hand, if you do not correct a bad corrosion situation immediately, you may lose the corroded facility entirely.

Suppose that before the serious corrosion situation arose you had had full knowledge of exposure tests in that area. Then, with the best surface preparation and the best possible materials you could find for the job, I think you could have given that area protection to the point where you would not be in the position of having to choose. Under those circumstances, periodic maintenance and spot repair would be the place where money is best spent.

I know of at least one building in which the paint was in a truly deplorable condition. After sandblasting, it was found that not only the paint was badly deteriorated. In some places the structural beams themselves had corroded to a point where almost fifty per cent of the metal was gone. If corrosion had gone much further, the building would have been lost, so that at that point something drastic had to be done.

Through very complete removal of all the old paint and scale down to the metal and recoating with one of the newer, more chemical-resistant materials in multiple coats to get very heavy protective films, corrosion was checked and the building continued to be useful.

Hence it is obvious that you can let a structure go a long way toward destruction and still do a fairly good job of reclaiming it.

Concerning the recognition of difficult areas in your plant, I think you will know which they are. Your experience will quickly tell you the performance of the coatings around your plant. You will know that some areas present great difficulty. These are definitely in the minority. Most areas give comparatively little trouble. A close look at the situation in your own plants will make that readily apparent.

A more difficult problem is that of predicting for a new structure that is not yet in operation. I think the only way you can do that is on the basis of other operating plants.

This brings us to another concept Mr. Dillon touched on, and which I believe is well worth emphasizing. That is that we can evaluate coatings in a paint laboratory, but we can never expect laboratory evaluation to tell us completely how paint will work in the field. The paint industry at large recognizes the need for field testing. The only way some problems can be solved is to conduct exposure testing right in the specific areas concerned, and, if possible, even on the specific surfaces involved, to learn which materials will work best.

Twenty years ago we did not have materials that could stand up under some chemical conditions. Today we do have them. They grew out of laboratory research, but the proof of their effectiveness came from careful field testing.

Another point which Mr. Dillon made and one on which I would like to comment is that of recognizing the causes of paint failure. I agree heartily with that suggestion.

Any laboratory, group or person studying painting and corrosion problems should go a step beyond just testing paints. I believe it is important to follow through to try to find out why some of them fail.

Certainly, when we run into a failure of any of our products, we like to explore further. Very frequently we find the cause is something other than the paint itself. It may—and often does—involve surface preparation.

Another place we find failures is in film permeability. All paint films are permeable to moisture to an extent. It is not common knowledge that they are, as a rule, as permeable to moisture and chemicals in the vapor phase as they are to those materials in the liquid phase.

If you have a chemical-resistant coating in which the film itself is capable of withstanding the environment yet you have a failure, in many cases you will find the damage did not occur because of paint failure. Rather, the failure was caused by penetration of the coating by liquid or vapor materials in the exposure environment. It was the result of the reaction of those liquids or vapors with the metal surface, resulting in corrosion and loss of adhesion.

In cases of that type, where the paint is resistant but the environment is very harsh on the surface, frequently your answer is simply sufficient film thickness. ▲

Tube Mill Practice

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Gas Turbines

. . . . prior to AISE presentation, this paper was presented before the ASME at their meeting in Washington, D. C., on March 2-6, 1958 . . . .

THE steel-mill blast furnace consumes large quantities of coke, iron ore, limestone and air. In addition to producing iron and slag, it also is a producer of large quantities of gas. For every ton of iron produced in the blast furnace, approximately 3 ½ tons of air are consumed and 4 to 5 tons of blast-furnace gas are produced, which represents a calorific heat content equivalent to 9000 lb of steam at 450 psi and 750 F. Eighty per cent of this heat is available for the production of power and for blowing blast furnaces. This blast-furnace gas is of low Btu content, ranging between 85 to 100 Btu per cu ft.[1]*

It has long been a challenge to the steel industry to develop equipment and means for utilizing more efficiently this by-product fuel. Historically, this fuel is used to fire power boilers, reciprocating gas engines, and blast-furnace stoves which are used to elevate the temperature of the air supplied to the furnace to heat the steel products such as ingots for further processing and rolling.

The gas turbine, as a prime mover, was considered, after careful research and study of existing installations, to be an acceptable and economical method of utilizing this gaseous fuel.[2]

Tests simulating operating conditions on a gas-turbine combustor using blast-furnace gas were conducted.[2] The favorable results of these tests led to the purchase of the gas-turbine blower, which will be discussed in this paper.

The advantages of the gas turbine versus other large prime movers include the reduction of operating personnel, smaller space requirements which often permit its installation in existing structures, minimum water requirements, the ability to locate the equipment close to the source of fuel and reasonable maintenance cost.[3]

The location selected for the installation of this unit was chosen to take maximum advantage of the desirable features of the gas turbine. At this site, five blast furnaces were blown by gas-engine driven reciprocating compressors.

A three-step program to replace these engines was initiated. In the development of this program, certain innovations in the art of blowing furnaces were adopted. The furnaces are small as compared to large modern furnaces, each consuming 50,000 to 70,000 cfm of air. It was desired to take advantage of the economics and future planning inherent in the installation of large modern blowers of 125,000-cfm capacity, which permitted the blowing of two of these furnaces with one blower. This was accomplished by installing measuring orifices and control valves in each blast main to control the air to each furnace. The control system permits the manifolding of one or more blowers to operate at pressures and volumes to satisfy the requirements of the connected blast furnaces.

Since there was sufficient steam available from an existing 450-psi, 750 F boiler installation, and water was available for the condensers from the mains feeding the blast-furnace cooling system to operate two steam-driven centrifugal compressors, Steps 1 and 2 proceeded accordingly. The completion of the second blower was realized recently.

However, the third step posed some real problems if a steam-driven unit was selected. An additional boiler would have been required and, because of limitation in existing gas lines, it would have been necessary to install the boiler in a location which is removed from the central power station. In addition, it was questionable that sufficient water supply would be available for operation of the unit without large additional expense.

Studies indicated that the gas-turbine blower could be installed on the existing foundation of one of the reciprocating engines, would fit into the existing building structure, and could use the gas lines and water supply originally utilized by the gas engines. These capital-investment savings were quite attractive.

Therefore, since the United States Steel Corp. desired to explore the advantage of the gas turbine as a prime mover, the installation of the gas turbine in this location was a "natural."

THE GAS-TURBINE BLOWER

Design features—The gas-turbine blower consists of two axial-flow compressors driven by a gas turbine. One compressor pressurizes the blast-furnace fuel gas from 8 in. of water up to 52 psia and the other compressor pressurizes air from atmospheric pressure up to 48.5 psia for the gas turbine and the cold blast air to the furnace.

Figure 1 is a schematic flow path for the complete plant. The blast-furnace gas is compressed in the fuel gas compressor which is geared to the main shaft of the gas turbine through a set of speed-increasing gears. The compressed fuel gas passes to the single combustor mounted beneath the gas turbine. The air flow from the main air compressor is divided, 38 per cent going to the cold-blast main for the blast furnace, the balance going to the regenerators where it is heated from 360 to 840 F. The air returning from the regenerator is combined with the fuel gas in the combustor where the temperature is raised to 1350 F. The hot gases then expand through the turbine exhausting at 950 F to the regener-

* Numbers in parentheses refer to references in Bibliography.

for Blast Furnace Blowing

by G. H. Krapf, Division Superintendent,
Power Production, South Works, United States Steel Corp., Chicago, Ill.
and J. O. Stephens, Section Manager,
Industrial Gas Turbine Dept., Westinghouse Electric Corp., Lester, Pa.

ator. The exchange of heat in the regenerator between the compressed air and the exhaust gases further reduces the exhaust temperature to 540 F.

To illustrate the division of air and gas flow at design conditions, the lower portion of Figure 1 shows the air entering the axial-flow air compressor as 100 per cent with the fuel-gas compressor adding 10 per cent of the weight flow to the cycle. Thirty eight per cent of the air is removed to blow the blast furnace and the remaining 62 per cent along with 10 per cent from the fuel-gas compressor enters the turbine. The main compressors are designed so that the coldblast flow can be shut off completely at full speed without causing instability (stalling or surging) of the axial-flow compressors. The turbine has been matched for this flow variation which provides one of the desirable features of the gas turbine for blast-furnace blowing.

A further review of the flow-picture shows that the balance of flow in the gas turbine burning low Btu gas is more complex than when burning high Btu gas or liquid fuel. An additional consideration must be given to the turbine volumetric flow when burning a high percentage of CO (as in blast-furnace gas) due to the reduction in volume of the products of combustion of CO. Inasmuch as the fuel flow and work of compression on the fuel, in the case of the low Btu gas, are factors in the turbine flow and turbine work, these must be balanced with the flow and work requirements of the axial-flow air com-

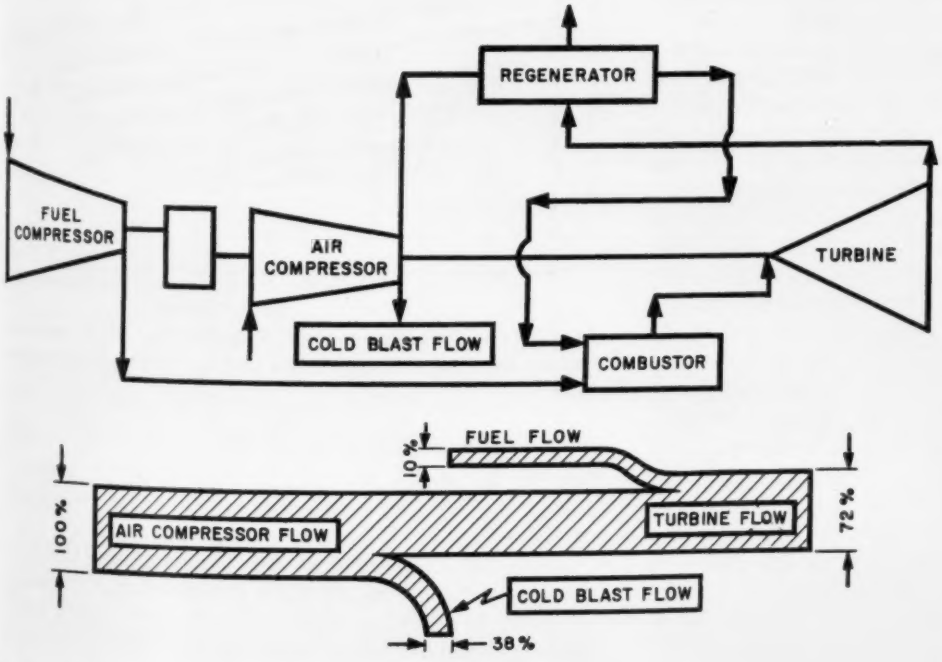


Figure 1 — Schematic flow diagram of regenerative cycle, one shaft 125,000-cfm gas turbine blower.

pressor. This can be better expressed by examining the work formula for the over-all machine. This is

Fuel gas compressor work + axial flow compressor work + losses = gas-turbine work

If variables are designated by

W_f = weight of fuel gas
C_{pg} = specific heat of fuel gas
T_{1G} = temperature of fuel gas entering gas compressor
T_{2G} = discharge temperature leaving gas compressor
W_a = total weight of air into axial-flow compressor
C_{pa} = specific heat of air
T_1 = inlet-air temperature to axial compressor
T_2 = discharge temperature from axial compressor
W_{fc} = fuel bypassed for control
W_{ext} = extraction air flow to blast furnace
C_p' = specific heat of products of combustion
T_3 = inlet temp from gas turbine
T_4 = exhaust temp from gas turbine

The following equation is developed

$$W_f C_{pg} (T_{2G} - T_{1G}) + W_a C_{pa} (T_2 - T_1) + \text{losses} = (W_f - W_{fc} + W_a - W_{ext}) C_p' (T_3 - T_4)$$

From this equation it is noted:

1. If the extraction flow is increased, the turbine-inlet temperature T_3 must be increased to produce more turbine work and balance the equation.
2. To obtain the increased turbine-inlet temperature, the amount of fuel W_f must be increased by ΔW_f which in turn shifts the work balance.
3. The added fuel will require work for compression, but its calorific content will produce ⅓ more work in expanding through the turbine than that required for compression.
4. The amount of fuel to be added ΔW_f must be reduced to where the work relationships on each side of the equation are equal.
5. The specific heats C_p will vary slightly as well as the component efficiencies of the compressors and turbines, which variables must be compensated.

Most of these variables are affected by ambient temperature so that the multitude of heat-balance calculations for each ambient temperature becomes extremely involved. To analyze the complete cycle at part load and variable ambient temperature, calculations have been programmed on a digital computer where all variables can be accommodated in a relatively short time.

The performance of the gas-turbine blower at standard conditions is shown in Figure 2, where furnace air pressure is plotted against furnace air flow, with parameters of speed and fuel flow. This field is bounded on the left by surge or pumping limit at low speed, by turbine temperature on the right, and speed at the top. As pointed out previously, should the furnace air be shut off while operating above 3200 rpm there is no surging of the gas-turbine blower.

The controls for the complete plant are arranged to serve the blast furnace at flows up to 125,000 cfm and 35 psig while maintaining the turbine in its operating field.

This machine exhibits the same outstanding features of all gas turbines in producing increased output at low

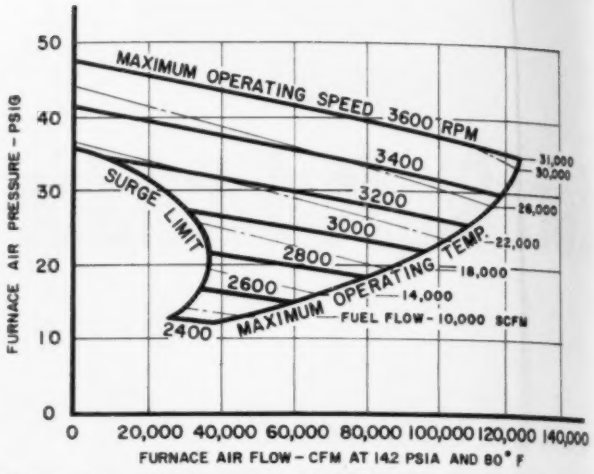


Figure 2 — Performance of 125,000-cfm blast furnace blower with blast furnace gas and 80 F ambient temperature.

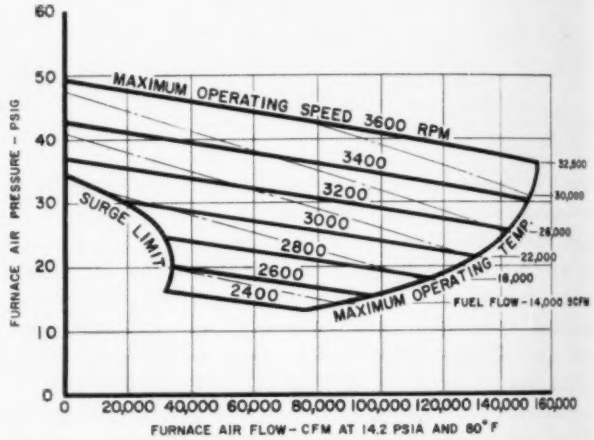


Figure 3 — Performance of 125,000-cfm blast furnace blower with blast furnace gas and 40 F ambient temperature.

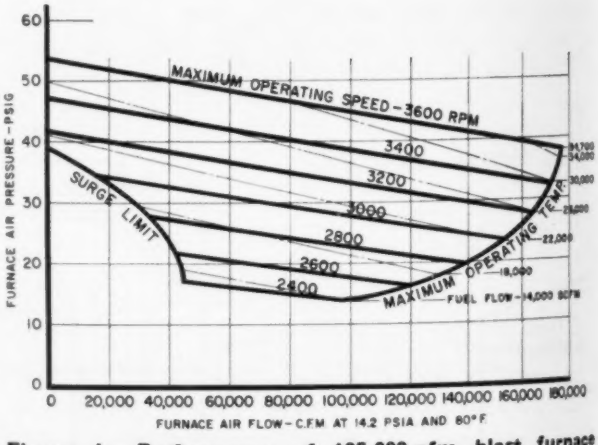


Figure 4 — Performance of 125,000-cfm blast furnace blower with blast furnace gas and 0 F ambient temperature.

ambient temperatures. Figure 3 shows that the air flow can be increased to 153,000 cfm at 40 F ambient. Figure 4 shows that the flow can be increased to as much as 175,000 cfm at 0 F ambient.

With constant turbine-inlet temperature, the temperature ratio across the cycle increased with decreased ambient, thereby improving the efficiency of the cycle. The regenerator further improves this effect since lower

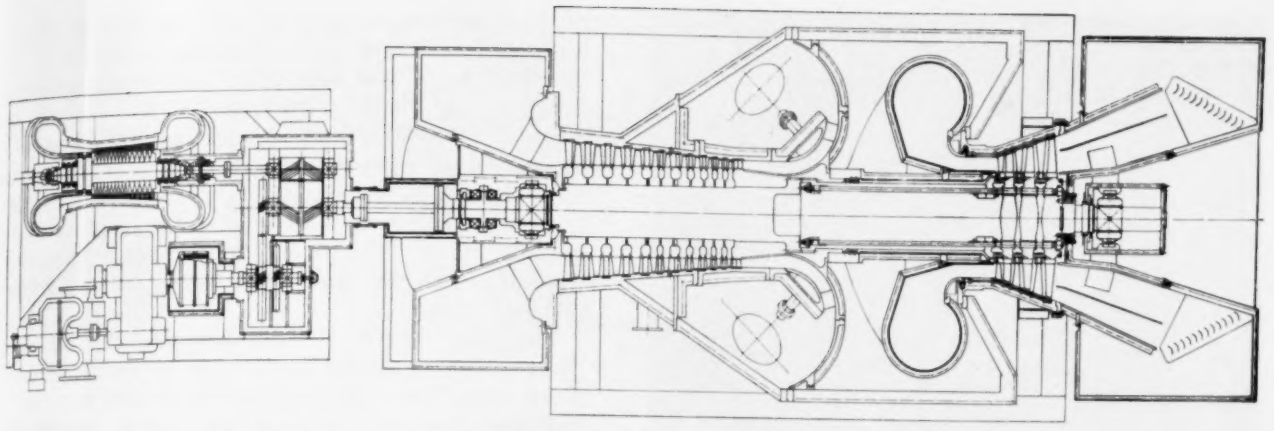


Figure 5 — Plan view of 125,000-cfm gas turbine blower.

compressor- discharge temperature will result in more heat being returned to the cycle. These effects materially increase the efficiency of the plant. Zero F ambient temperature will result in 40 per cent increased flow to the blast furnace with less than five per cent increase in fuel, or at design flow, 125,000 cfm at 35 F will be obtained with 13 per cent decrease in fuel.

DESCRIPTION

For a general description of the components for this cycle, Figure 5 is a plan view of the machine with covers removed. The fuel-gas compressor on the left is a 15-stage axial-flow compressor. Steam is admitted to labyrinth seals at each end to prevent leakage of the blast-furnace gas to the operating room. The design conditions of the compressor are as follows:

a. 42 lb per sec gas flow
b. 14.17 psia suction
c. 5.3 pressure ratio (max)
d. 8700 rpm.

The compressor casing has a horizontal joint to facilitate maintenance and inspection. The stationary blades are shrouded both on the inner and the outer diameter to provide a rigid assembly. The rotating element consists of high-strength carbon-steel disks shrunk into a solid steel shaft. Dovetail blade roots fit into axial grooves in the disks permitting individual blade replacements without disturbing the remainder of the blades. Figure 6 shows blades being installed in this type compressor.

The axial thrust of the fuel-gas compressor rotor is largely balanced by a balance piston which is an integral part of the rotating element. Leakage from the balance piston is bled back to the inlet of the compressor. The residual thrust of the compressor is taken by a segmented-type thrust bearing.

The fuel-gas compressor is solidly coupled to the stepup gear by a relatively long flexible shaft. This, in turn, positions the stepup gear from the thrust bearing of the fuel-gas compressor. The gear is a double helical type stepping the speed up from the main shaft at 3600 to 8700 rpm for the pinion to the fuel-gas compressor.

Proceeding to the gear train, at the end of the 3600-rpm, double helical gear is a single helical gear for driving the lubricating-oil pumps, a governor of the reverse flow impeller type, and an overspeed trip mechanism. Meshed with this same single helical gear is a gear train for the starting turbine and motor-driven turning-gear assembly. The main reduction gear is coupled to the axial-flow air compressor with a single flexible gear tooth coupling and quill shaft.

The starting turbine is connected to the gear train through an air-operated friction-type clutch which may be engaged or disengaged at any speed of the gas turbine up to 70 per cent of full speed.

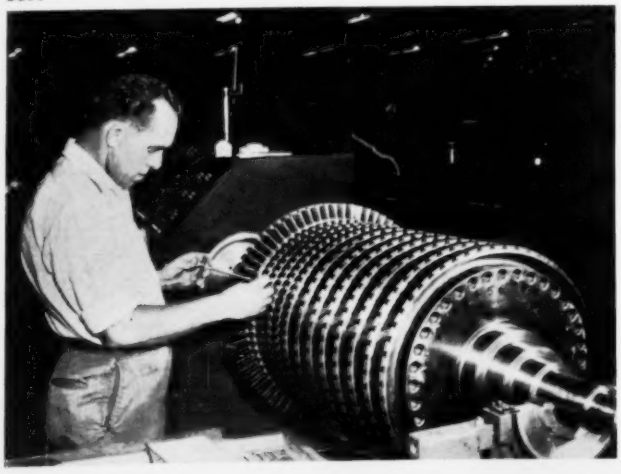
The starting turbine is sized to crank the unit to deliver 5-psi air pressure at the compressor to assure no leakage or back flow from the blast furnace in the event of an emergency shutdown. This is an added precaution (in addition to the standard check valve to the blast furnace) that is permitted with this design of starting arrangement.

The main air compressor consists of an eleven-stage axial-flow unit with the following design conditions:

a. 401 lb per sec air flow.
b. 4.8 pressure ratio (max).
c. 14.17 psia suction pressure.
d. 3600 rpm speed.

Mechanical construction of the rotor blading and diaphragms follows the same pattern as the fuel compressor but on a larger scale. The discharge from the compressor is diffused in a radial-type diffuser discharging through three 48-in. pipes. The bottom connection leads to the blast furnace and the other two connections lead to the regenerators.

Figure 6 — Blades are being installed on fuel-gas compressor.



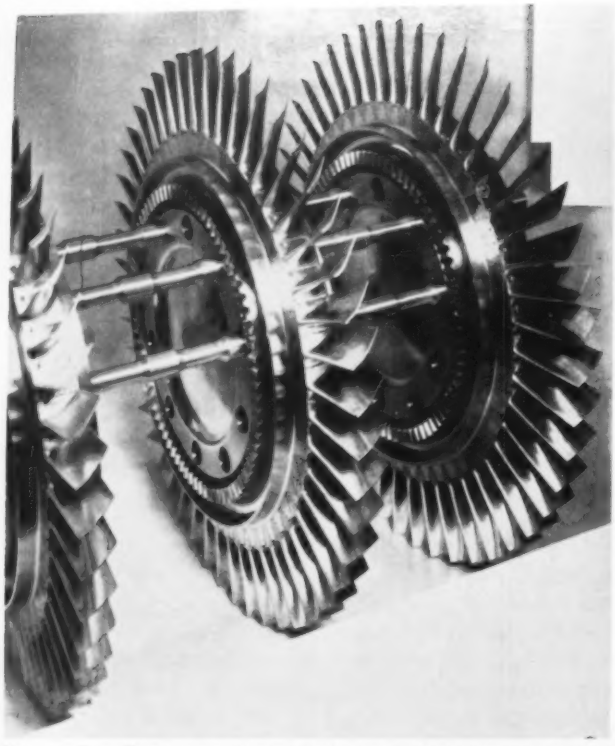


Figure 7 — Rotor consists of three pancake type forged disks.

The combustor is mounted vertically beneath the machine and the hot gases flow upward into the inlet hood to the turbine. The hood, constructed of stainless steel, is surrounded with 800 F air from the regenerator. This member retains the hot gases (1350 F) while the outer shell is the pressure-retaining member. The only stresses on this hood are created by the pressure drop across the combustor and the thermal gradient. Since thermal gradient becomes a major design criterion at elevated temperatures, the thickness of this hood is held to a minimum and allowance for three-dimensional thermal expansion is designed into its supporting system.

Hot gases enter the three-stage axial-flow turbine and are exhausted at 10 in. H_2O. The turbine is principally of the reaction type with tapered and twisted rotating blades of forged Inconel X. The blade fastenings are the "fir-tree" type with side entry permitting individual removal. The blades are designed to fit loosely in the rotor for differential thermal expansion and are retained by individual locking pins. The stationary blades retained axially by inner and outer shrouds firmly welded to form a diaphragm construction. The diaphragms are retained in the cylinder by grooved blade rings, thus separating the hot high-temperature parts from the turbine cylinder.

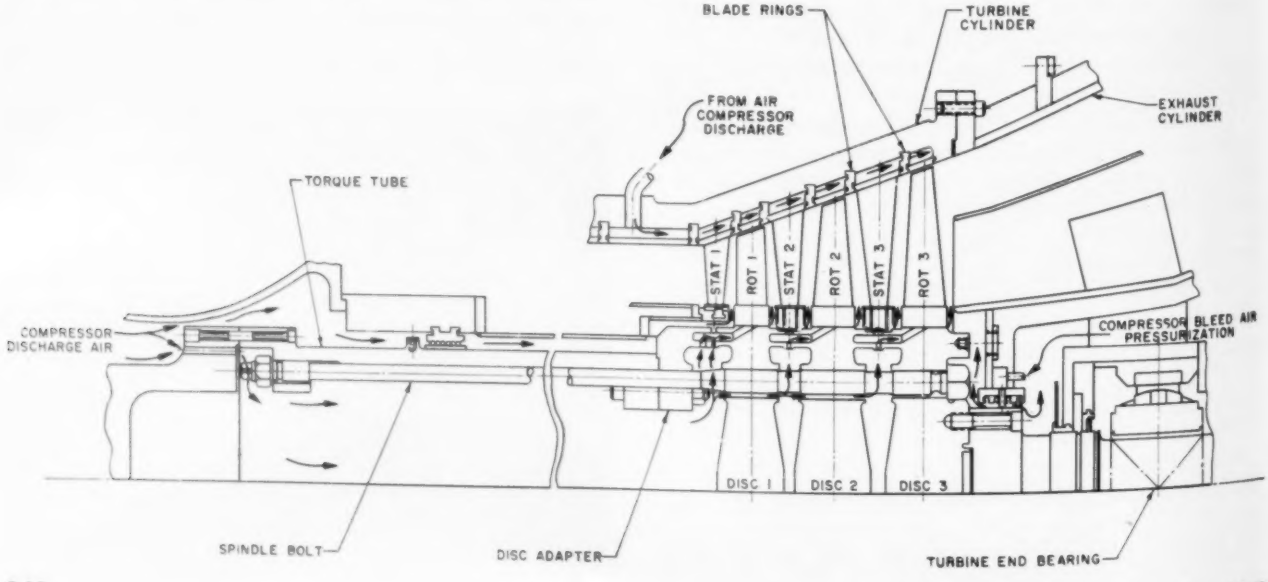
The rotor for the turbine is constructed of three "pancake" type forged disks made of special chrome-nickel alloy. The disks are coupled together by a curvic coupling through the torque tube which connects the compressor to the turbine in a similar manner to that shown in Figure 7.

The added length of these bolts, plus their variation in diameter, permit them to be prestretched at assembly so that differential expansions may occur in the individual disks and yet the bolts retain a uniform force holding the rotor together.

To provide cooling for the turbine rotor, air from the axial-flow compressor is admitted to the hollow torque tube as shown in Figure 8. It passes radially out through the rotor ahead of the first disk. Part of the air continues out radially and passes through holes in the first disk to the base of each blade providing a blanket of cool air around the disk and blade roots. The remainder of the air passes through the bolt holes in the disk which have been sized to accommodate the bolt as well as provide space for the cooling air. Between each successive disk, a portion of the air flows radially outward through the curvic clutch and beneath each blade. This maintains all of the rotor body well below the temperature of the gases passing through the turbine.

In order to cool the turbine cylinder, a small portion of the compressor air is fed into the passage around blade rings which retain the blade diaphragms in the cylinders. The cooling air is metered by holes in each blade ring as it passes downstream so as to maintain a pressure slightly higher than the respective stage pressure. This provides a cool blanket of air on the outside of

Figure 8 — Sketch shows cooling air flow for turbine cylinder and rotor.



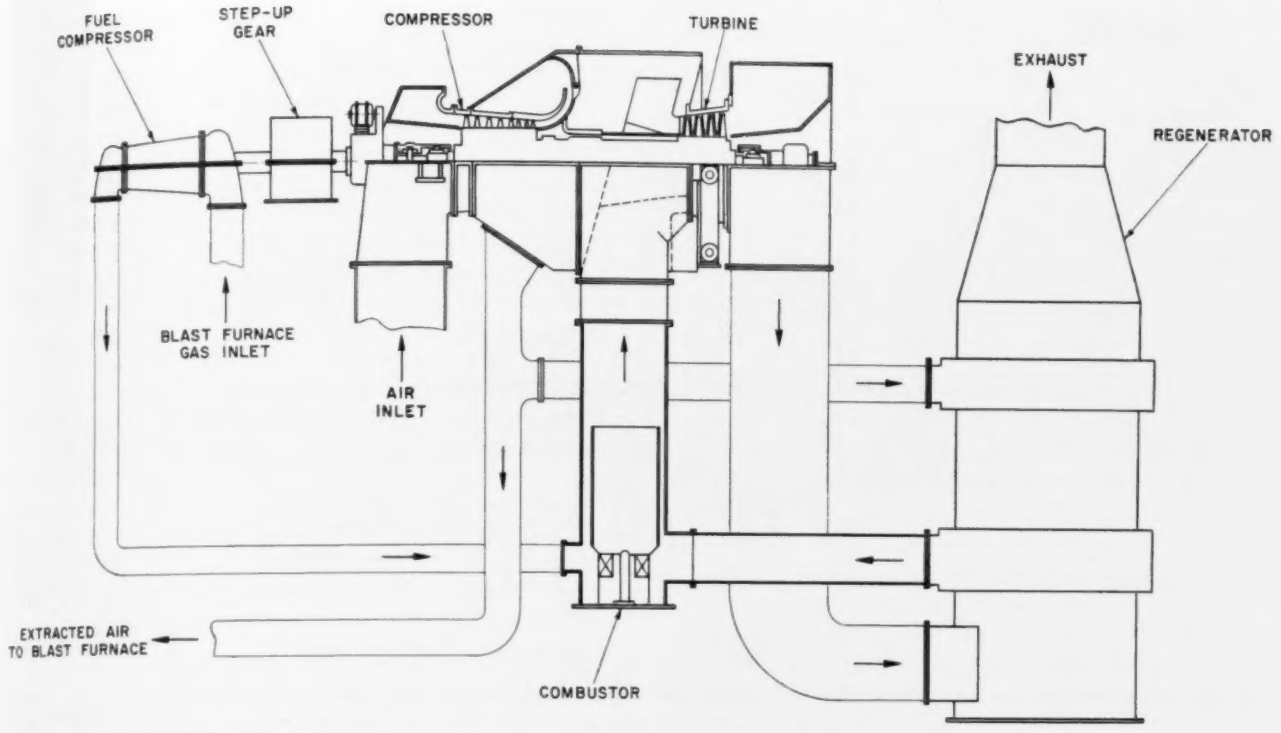


Figure 9 — Vertical cross-section through complete 125,000-cfm extraction gas turbine.

the stationary blades confining the hot gases to the blade path and preventing them from impinging on the turbine cylinder.

A side elevation of the gas-turbine blower, Figure 9, shows the flow from the air compressor to the regenerators. The regenerators consist of two heat exchangers, arranged side by side, permitting symmetrical piping arrangements on each side of the machine. Each regenerator is of the shell-and-tube design with counterflow heat transfer. There are 18,000-¾-in. gage steel tubes in each regenerator rolled into steel headers. The weight of the tube bundle is supported on the lower tube sheet, which is flexibly supported on steel flex plates. The tubes are baffled by plates that are retained in an inner shell to assure uniform heating of the tube bundle. Differential expansion of the tube bundle and the outer shell is taken in the two air headers at the top and bottom of the heat-exchanger portion.

The heated air flows from the generator to the single combustion chamber which is mounted vertically beneath the turbine and fired upward. The inner basket is made of ¼ in. 25-20 stainless steel, 6 ft in diameter and 15 ft long, with six fuel-oil nozzles surrounded by register-type swirl plates where the blast-furnace gas enters the combustion zone. Fuel oil is used for starting and auxiliary firing. A small torch igniter is mounted in the center of the nozzle cluster to insure positive ignition during starting and operation. The combustor basket is made in three sections and can be removed by sections from the base of the combustor shell. The basket is sup-

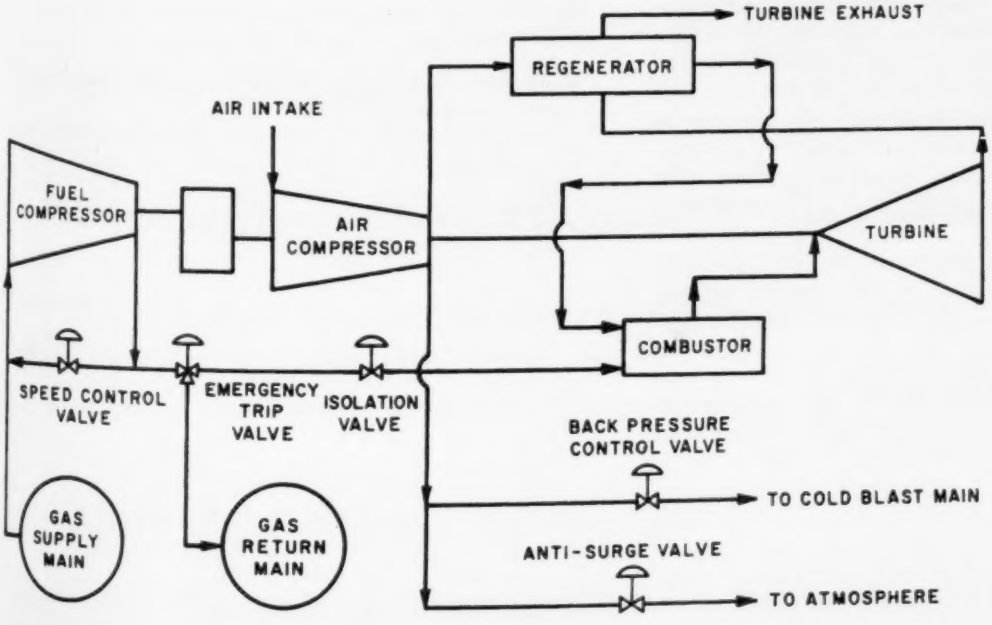


Figure 10 — Control diagram for 125,000-cfm blast furnace blower.

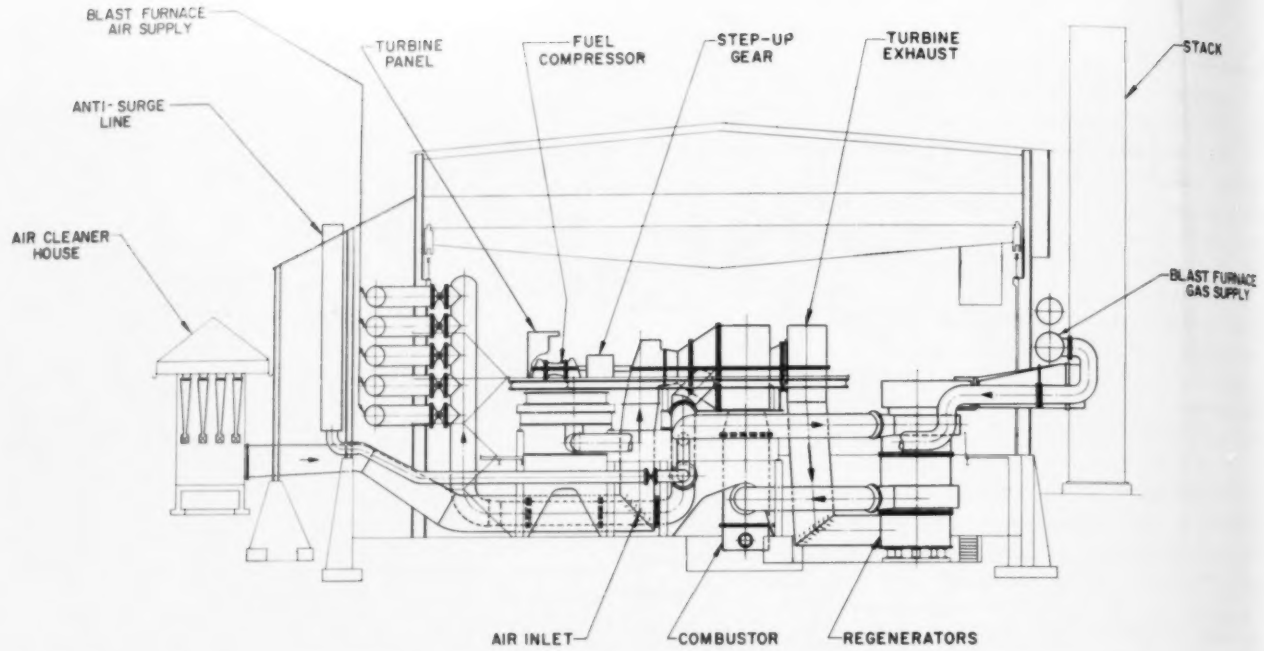


Figure 11 — Blast furnace gas turbine blower is being installed in the plant as indicated in this sketch.

ported by tangential rods to the combustor shell to provide a flexible support permitting expansion of the basket without causing undue stresses.

Upon leaving the turbine, the exhaust flow is divided, splitting 7 x 7-ft ducts each leading to a regenerator. Exhaust from the regenerator passes outside of the building and enters a single exhaust stack.

CONTROL

The complete plant will be started on distillate oil fuel after the fuel-gas compressor has been purged and filled with blast-furnace gas. The fuel gas will be taken from one fuel gas main and discharged to a second fuel gas main during this starting period as shown in Figure 10. The fuel-oil control is a spill-type system the same as employed on similar dual-fuel gas turbines. Once the machine has reached an idling speed of approximately 2600 rpm of the turbine shaft (with oil firing), the isolation valve on the gas fuel line is opened, the emergency trip valve is closed, and the governor is set to position the speed-control valve. As the governor setting is increased, sufficient pressure in the fuel line is built up to open the check valve and force fuel gas into the combustion chamber. As the speed increases, the governor switches the fuel from fuel oil to blast-furnace gas.

In the event of irregular gas conditions, fuel oil will be injected to add sufficient heat to maintain the turbine at desired speed until normal conditions are re-established.

Upon shutdown for either normal or emergency conditions, the isolation valve is closed and the emergency trip valve is opened removing the supply of fuel gas to the combustion chamber. The oil-fuel system is simultaneously shut down. On coast down, if desired, the starting turbine can be re-engaged to maintain 5-psi discharge pressure from the axial-flow air compressor.

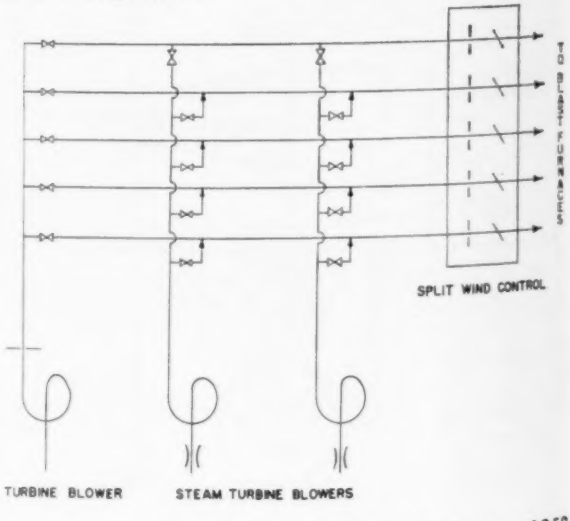
As stated earlier, the control system is designed to provide operation at any pressure below the 3600-rpm line, as shown in Figure 2, up to a flow of 125,000 cfm for 80 F ambient temperature. In addition, the control functions are modified for ambient temperature to extend this field of operation as shown in Figures 3 and 4.

OPERATION

Figure 12 illustrates schematically the relationship of the gas-turbine blower to the two steam-turbine blowers and to the furnace-air weight-flow control system which controls the required flow of standard air to the consuming blast furnaces. Because the three turbine blowers are manifolded as shown, many operating "set-ups" can be obtained.

The split-wind control meters and controls the required standard wind to the furnaces. Each furnace receives constant flow of blast air and the flow is controlled by automatic regulators with density correction. The final control device is a butterfly valve positioned by hydraulic operating cylinders.

Figure 12 — Schematic diagram shows blast furnace control arrangement.



The blowers can be regulated to deliver a fixed discharge pressure at approximately 1 to 1½ psig above furnace pressure. This slight increase is necessary for control purposes at the butterfly valves. If the furnace pressure changes, requiring more or less opening of the butterfly valve to deliver the desired mass rate of flow, reset of the blower-discharge pressure is compensated within a range of five psi by speeding up or slowing down the turbines to maintain a new pressure at the butterfly valves. It is necessary with such an arrangement that only the furnace with the highest pressure can furnish this compensating impulse; however, the controls are so designed that this function is freely selective in that any one of the five furnaces may provide the impulse at any instant of time. In addition, this control can be arranged for any desired grouping of furnaces and each group operated as stated.

Since each turbine blower is equipped to measure and control the volume of air it produces, any furnace can be blown directly with a blower.

With this flexible arrangement, it will be possible to operate the gas turbine in the following combinations:

1. Blowing one furnace, utilizing its volumetric controls.
2. Blowing two furnaces through the split wind control.
3. In combination with one steam-turbine blower—blowing two, three or four furnaces through the split wind control.
4. In combination with two steam-turbine—blowing up to five furnaces through the split wind control.

In cases (3) and (4), the gas turbine could be operated at constant weight flow; the steam turbines varying in speed to maintain required pressure.

Operating experience will determine the best combinations.

SUMMARY

The gas-turbine blower plant discussed will permit safe, economical and flexible operation of the connected blast furnaces; safe, in that provisions are made in the installation to assure minimum air requirements; economical, in that it compares favorably to the best steam-turbine installations for this service; and flexible, in that the output can be maintained in all of the operating field under the maximum speed line.

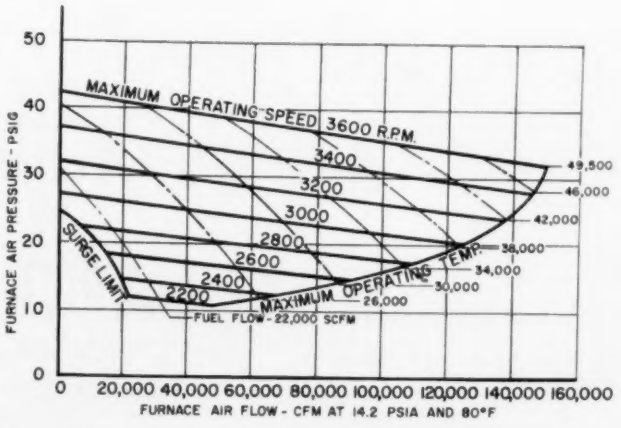


Figure 13 — Diagram shows performance of 150,000-cfm, simple cycle, gas turbine blower at an ambient temperature of 80 F.

Other installations under different conditions may dictate other than the regenerative cycle.

The gas-turbine blower could be operated in a simple cycle which would increase the usable output of the machine by 20 per cent with an increased fuel flow of 60 per cent as shown in Figure 13. The efficiency of the cycle, however, could be maintained at approximately the same level by the use of a waste-heat boiler for producing process steam or for feedwater heating for a steam plant. In either case, if the turbine blower is credited for the heat recovery, the calculated efficiency of the gas-turbine blower shows an efficiency increase over the best modern steam-turbine blowing plant.

We are looking forward to the experience of operating this gas turbine. This unit should generate many applications in the minds of engineers and operators for this versatile prime mover; not only for blowing of furnaces, but for the production of power and other allied applications.

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CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, October 27, 1958—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Two Years' Operation with Class H Insulated Mill Motors," by C. R. Steen, Manager of Engineering, Elliott Co., Jeannette, Pa.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, October 14, 1958—Dinner 6:30 P.M., Meeting 8:00 P.M.

"A Recent Trip Through Polish and Russian Steel Facilities," by Floyd S. Eckhardt, Assistant General Manager, Bethlehem Steel Co., Lackawanna, N. Y.

Hotel Sheraton, Buffalo, N. Y.

CHICAGO SECTION

No October Meeting

CLEVELAND SECTION

Tuesday, October 21, 1958—Social Hour 6:00 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

"Use of Steel in Prestressed Concrete," by W. O. Everling, Research Engineer, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

Cleveland Engineering and Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, October 14, 1958—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

TWENTIETH ANNIVERSARY

"Electric Data Processing," by William K. Smith, Systems and Procedures Dept., Controllers Office, Steel Div., Ford Motor Co., Dearborn, Mich.

Main Ballroom, Fort Shelby Hotel, Detroit, Mich.

LOS ANGELES SECTION

Monday, October 13, 1958—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Details Not Available.

Michaels Restraurant, 6309 E. Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

No October Meeting

PITTSBURGH SECTION

No October Meeting

ST. LOUIS SECTION

Wednesday, October 29, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Application of Feed-In Duct in Heavy Industry," by George N. Jorgensen, Application Engineer, Switchboard and Bus Duct Section, Square D Co., Detroit, Mich.

SAN FRANCISCO SECTION

No October Meeting

UTAH SECTION

Monday, October 13, 1958—Social Hour 6:30 P.M. Dinner 7:30 P.M., Meeting 8:30 P.M.

"Refractories in Industry," by G. R. Eusner, Chief, Refractory and Mineral Technology, United States Steel Corp., Applied Research Laboratory, Monroeville, Pa.

Grand View Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, October 27, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

BOSSES NIGHT

Speaker to be announced

Mural Room, Youngstown, Ohio

Recent Hot Strip Mill Roughing Trains

. . . . trend in roughing stand drives on hot strip mills is to the usage of 6000-hp, synchronous motors on roughers which follow the broadside stand . . . . broadside stands use wound-rotor motors of from 3500-hp to 5000-hp . . . . inching equipment and dynamic braking are common accessories . . . .

by John H. Greiner
Application Engineer
Electrical Application Dept.
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

BACK in the thirties, the great majority of the roughing mill stand motors were wound rotor with supporting flywheels. Horsepowers ranged around 1000 for scalebreakers and 3000 to 3500 for roughing. Maximum slab thickness seldom exceeded 6 or possibly 6½ in. Delivery speeds from the roughing trains averaged about 450 fpm.

With the exception of the scale breaker, it was customary to use 500 to 514 rpm motors with double reduction gears. This combination resulted in the most economical application because the savings in the motor and flywheel more than offset the increased cost of a double reduction gear.

As power system capacity increased, it was felt that possibly a synchronous motor could be used on the last roughing stand. This proved to be true, so the next step was to use synchronous motors throughout with the exception of the broadside mill.

98-IN. ROUGHING TRAIN

A typical 1937 installation for a 98-in. wide mill is shown on Figure 1. In the background, where unfortunately it cannot be seen, is an 800-hp wound-rotor motor driving the scalebreaker. The three motors in the foreground, as well as one other not shown, are wound-rotor and rated 3000 hp at 514 rpm. Each motor is connected to a double reduction gear with flywheels on opposite ends of the high speed pinion shaft.

In 1953, No. 4 stand motor, which was the last one in the roughing train, was changed to a 5000-hp 514-rpm wound-rotor unit. This was accomplished by keeping the original base and bearings intact and supplying a new stator and rotor with a core length somewhat greater than that of the original motor. The original motor had full stator shift and some of this space was taken by the increased core length.

In 1956, it was decided that this entire 98-in. roughing train should be repowered as heavier slabs would be available from a new slabbing mill. In order to keep downtime to a minimum, it was mandatory to reuse as much of the original equipment as possible and do it without disturbing the motor foundations whenever possible.

Consequently, the rotor and stator of the 5000-hp wound-rotor motor were taken from No. 4 stand and reused on the broadside drive.

For stands 2, 3 and 4, 6000-hp synchronous stators and rotors were built and these along with larger bearings were placed on the undisturbed 3000-hp bases to form 6000-hp motors running at 514 rpm with 300 per cent pull-out-torque. Needless to say, all the available space from the original stator shift was used in this conversion. Increased width for the higher torque mill gears was obtained by utilizing space which was formerly taken by the flywheels.

Figure 1 — Original motor room installation of 98-in. hot strip mill unit consisted of 3000-hp, 2300-v, 514-rpm slip ring motors with an 800-hp, wound-rotor motor on the scalebreaker.

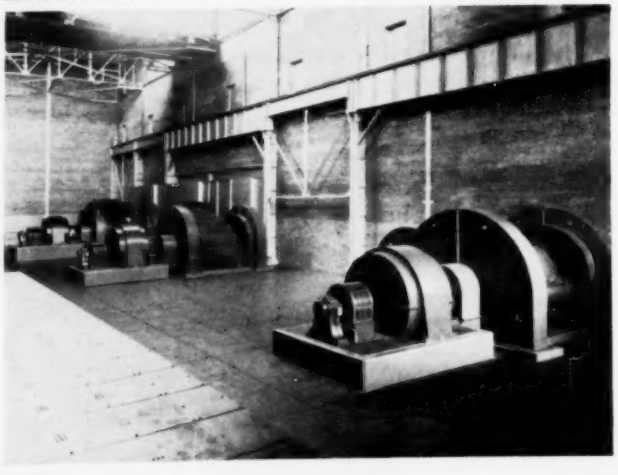


TABLE I
98-In. mill

Mill stand	1937, hp	1953, hp	1957, hp
Scale-breaker	800†	800†	6000*
Broadside	3000†	3000†	5000†
Stand No. 2	3000†	3000†	6000*
Stand No. 3	3000†	3000†	6000*
Stand No. 4	3000†	5000†	6000*

* Synchronous.
† Wound rotor.

The 800-hp scalebreaker motor was completely removed and in its place went a 6000-hp synchronous motor as described above, but with a new base duplicate of the original ones supplied with the 3000-hp motors in 1937. Table I summarizes this mill throughout its various eras.

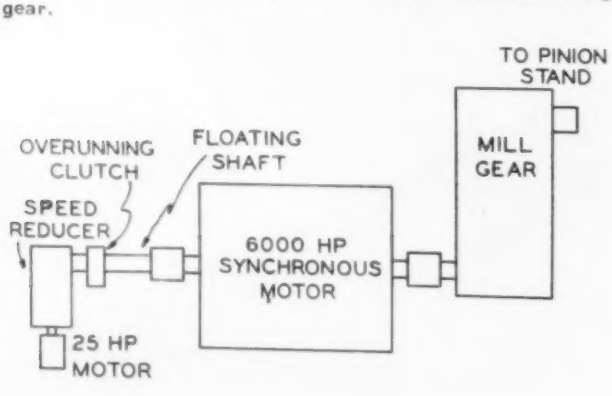
Column two is the original installation while column three is almost the same except the hp of the last stand has been increased to 5000. The last column is the present installation, which in addition to increased hp also provides flexibility in case of any failure. Anyone of the last three motors could be replaced by the scalebreaker motor. Either the scalebreaker or broadside motors could be replaced by one of the original 3000-hp motors as one will be kept as a spare.

In the matter of roll changing, there is the ever present problem of positioning the spindles properly. In the past, it has been done by closing and then immediately opening the stand motor breakers. Where the spindles stopped was a matter of chance, and this hit and miss operation was time consuming and gave the circuit breaker a duty for which it was not designed.

For the purpose of accurately and quickly inching these synchronous motors during a roll change, a turbine type turning gear was designed. Figure 2 shows a block diagram of the turning gear. Basically it consists of a squirrel cage driving motor, a right angle speed reducer, an overunning clutch and a floating shaft.

The output torque of the turning gear is 30,000 ft-lb which is approximately 50 per cent of rated torque of the 6000-hp stand motors. This turning gear torque is obtained by using a 25-hp, high slip, high torque motor with a 15-min rating in conjunction with a speed reducer which has an over all ratio of 120 to 1. This reduction, plus that of the mill gear, results in a work roll speed of 0.33 rpm for the scalebreaker, 0.55 rpm for rougher No. 2, 0.77 rpm for rougher No. 3, and 1.1 rpm for rougher No. 4.

Figure 2 — Schematic diagram shows operation of turning gear.



The output shaft of the turning gear has an overunning clutch which produces positive, nonslip driving action in the forward direction by wedging of rollers between inner and outer races. In the reverse direction, free-wheeling is obtained. This feature provides instantaneous automatic disengagement whenever the stand motor is started. Between this clutch and the end of the stand motor is a floating shaft to take care of any possible misalignment. This turning gear assembly adds five feet to the over all length of the stand motor, 16 in. of which is due to the floating shaft.

Because of the fact that an overrunning clutch is used, the turning gear is unidirectional in nature. It was felt that this could be tolerated because of the simplicity and low cost. The only disadvantage is that if a roller overshoots his mark, he cannot back up but must continue for another 180-degree movement of the spindles. Control of the turning gear is done from the roughing mill pulpit with a pistol grip switch.

With this type of turning gear, no interlocking, either electrical or mechanical, is required. Practically all units making up this turning gear assembly are taken from standard designs.

86-IN. ROUGHING TRAIN

The 86-in. mill was a completely new installation and the planners were not hampered by existing conditions such as were encountered with the previous mill.

Schedule A, which is shown on Table II, is a power calculation covering the rolling of a 7-in. thick, 62-in. wide and 110-in. long slab to ¾-in. thick and 84 in. wide. The peak hp encountered is shown in the fourth column and if we consider 6000-hp motors for the last

TABLE II
86-In. mill—Schedule A

Stand	Thickness and width, in.	Speed, fpm	Hp per stand	Connected motor hp	Per cent motor load
O	7 x 62 (110)	..	...	...	..
RSB	6 x 62	215	3,600	3000	120
Broadside	4 7/16 x 128	203	11,500	5000	109*
R2	3 x 84	337	14,400	6000	241
R3	2 x 84	443	15,280	6000	254
R4	1¼ x 84	560	15,900	6000	264
R5	¾ x 84	560	14,100	6000	235

* Plus 12,500 hp-sec from flywheel.

TABLE III
86-In. mill—Schedule B

Stand	Thickness and width, in.	Speed fpm	Hp per stand	Connected motor hp	Per cent motor load
O	5½ x 42 (105)	..	...	...	...
RSB	4½ x 42	215	2,640	3000	88
Broadside	2¼ x 128	203	16,980	5000	218*
R2	1⅝ x 84	337	7,130	6000	119
R3	1¼ x 84	443	7,440	6000	124
R4	1 x 84	560	8,000	6000	133
R5	¾ x 84	560	8,460	6000	141

* Plus 12,500 hp-sec from flywheel.

four stands, the load percentages range from 235 to 264 per cent. Consequently, 6000-hp motors with 300 per cent pull-out-torque were chosen. The roughing scalebreaker and broadside stands are running relatively light.

Schedule B, which is shown on Table III, covers the rolling of a 5½-in. thick, 42-in. wide and 105-in. long slab to ¾-in. thick and 84-in. wide. In this schedule, we are primarily interested in the loading of the broadside stand which peaks at 16,980 hp for slightly more than two seconds. It was found that a 5000-hp motor in conjunction with flywheels totaling 40,000 hp-sec would do the job with a peak loading of 218 per cent on the motor.

With the hp-ratings established from torque and rms calculations, the next step was to select the most favorable combinations of equipment for each stand. This word combination takes into account not only the motor and gear, but also primary and secondary control and excitation and ventilation requirements.

In analyzing all stands, with the exception of the broadside, it was found that the least expensive combination was to use single reduction gears with relatively low speed motors. The gear prices took a nosedive when going from double to single reduction whereas the motor prices climbed moderately as their torque ability was increased.

Table IV gives the various values that were selected.

The wound-rotor motor on the broadside stand was a different matter. Here the combination of equipment making up a drive for a stand involves the addition of flywheels. Analyzing this on the basis of 514-rpm and 150-rpm motors, it was found that the 514-rpm combination with a double reduction gear was the most economical. The flywheels tipped the scales here because, academically, at 150 rpm, the flywheels would weigh 15 times more than those with the same capacity at 514-rpm.

In preparing this paper, the thought arose that possibly a synchronous motor could be used on future broadside stands. Table V compares the loading of roughing stand No. 4 on schedule A with the loading of the broadside stand on schedule B. It will be noticed that rougher No. 4 is only taking a draft of ¾-in. but at a speed of 560 fpm which results in a peak hp of 15,900. The broadside mill is taking a 2¼-in. draft but at a relatively low speed of 203 fpm which results in a peak of 16,980 hp.

There is virtually no difference in the peaks of the two stands. The only difference that does occur is in the pass duration where the rougher is loaded for 4.21 sec while the broadside stand is loaded for 2.07 sec. However, this difference should be of no consequence.

A synchronous motor for this peak load would be rated at 7000 hp with 300 per cent pull-out-torque and this motor running at 150 rpm with all its associated equipment such as switchgear with neutral reactor start, excitation system, ventilating equipment and single reduction mill gear would be considerably less expensive than a 5000-hp 514 rpm wound-rotor-motor with all its associated electrical equipment and double reduction mill gear.

In addition to saving on the initial investment, there would also be an annual saving in power because of lower operating and standby losses.

Because of all these savings, it would be desirable to power the broadside stand with a synchronous motor. However, this possibility will have to be explored further in the future as there may be a remote possibility of some condition which would make the synchronous motor inapplicable. However, the benefits to be gained warrant an investigation.

TABLE IV
86-In. mill

Mill stand	Hp	Motor rpm	Mill fpm	Drive ratio
RSB	3000*	150	215	7.23
Broadside R1	5000†	514	203	27.85
R2	6000*	240	337	7.84
R3	6000*	360	443	7.23
R4	6000*	360	560	5.71
R5	6000*	360	560	5.71

* Synchronous.
† Wound-rotor.

TABLE V
86-In. mill

Stand	Schedule	Per cent reduction	Draft, in.	Speed, fpm	Hp per stand	Pass duration, sec.
R4	A	37.5	¾	560	15,900	4.21
Broadside	B	50.0	2¼	203	16,980	2.07

ELECTRICAL DYNAMIC BRAKING AND INCHING

It goes without saying that mills want to keep any downtime to a minimum. As an aid in accomplishing this, many mills are purchasing dynamic braking equipment along with inching equipment. The dynamic braking equipment is used to bring a motor and associated stand to a rapid stop rather than let is lazily coast to rest. Worn rolls can then be removed and new ones installed. Figure 3 illustrates how this dynamic breaking functions.

Only two motors are shown for this explanation. "A" is a synchronous motor such as is used on a scalebreaker while "B" is a wound-rotor motor as may be used on a broadside mill. Immediately above the motors are the 6600-volt switchgear breakers. The odd numbered breakers supply power to the motors in the conventional manner while the even numbered breakers are used for isolating purposes.

Assume that motor "A" is running at full speed and the running breaker is tripped which in turn removes the field excitation. If this motor was allowed to coast to a stop, it would require six to eight minutes for some of the higher speed motors and four to six minutes for the lower speed motors. However, if the isolating breaker is closed, d-c current is then fed into the stator of the synchronous motor. A steady state flux is created in the stator and the rotor damper bars cutting this flux produces generator action which retards the rotor speed and stopping can be accomplished in ¼ or ⅕ of the normal coasting time. The greater the kw poured into the stator winding, the shorter the stopping time. This is analogous to starting a synchronous motor where greater kva poured into the stator results in a shorter accelerating time.

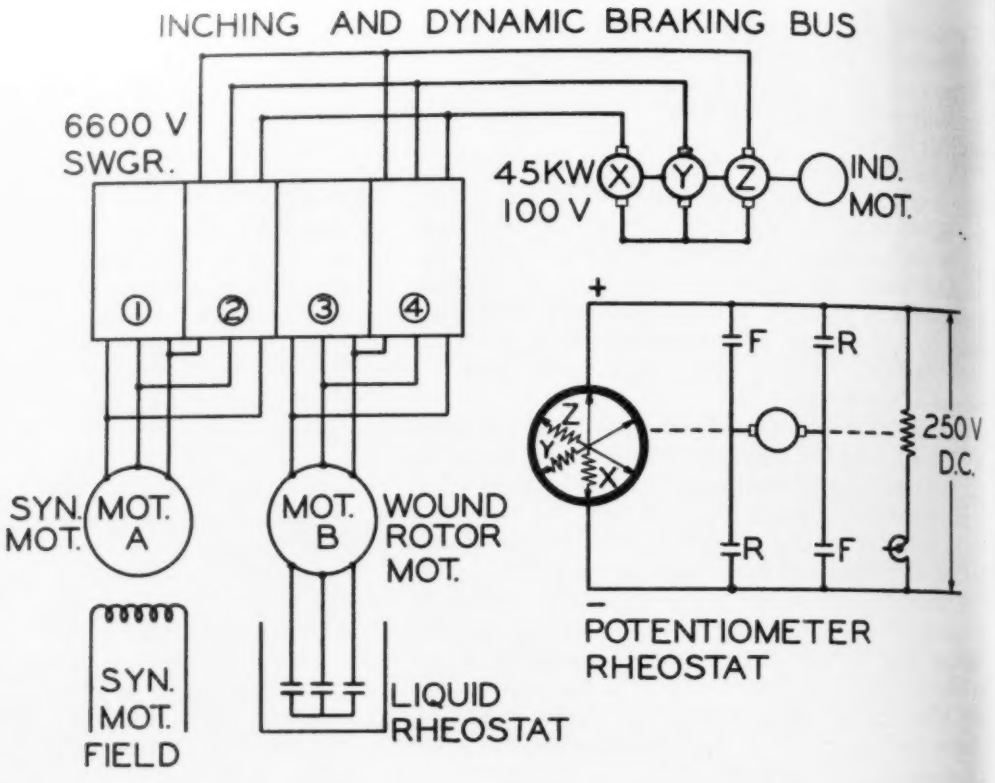


Figure 3 — Schematic diagram shows operation of inching and dynamic braking control.

After the motor is at standstill, it can be slowly rotated by applying low-frequency alternating voltage to the stator while the field has its normal excitation.

The fields of the inching generator are controlled with a potentiometer rheostat stepped so that the output voltage of the generator is varied sinusoidally from a positive maximum to a negative maximum. The rheostat consists of a fixed commutator, the segments of which are connected to taps on a potentiometer resistance stepped to provide the sine-wave output. Surrounding the commutator is a rotating brush rigging mounting three pairs of brushes. The pairs of brushes are separated from each other by 120 degrees. The entire brush rigging is rotated around the commutator by an adjustable speed d-c motor.

Dynamic braking and inching of the wound-rotor motor is done in virtually the same manner except that here on inching, the current is induced in the secondary the same as is done when operating on regular 60-cycle power. Without dynamic braking on the broadside motor, the flywheels could continue rotation for possibly 45 or 50 min. Dynamic braking will cut this down to approximately two minutes.

This 86-in. mill is set up so that one inching and dynamic braking motor-generator set can be used for any of the six stand motors driving the roughing train. A selector switch is installed on the roughing train pulpit for making this choice.

This electrical scheme is higher in cost than the turning gear scheme, but it has the added advantage of dynamic braking and bidirectional operation on inching.

Synchronous motor stopping time could be decreased to mere seconds by employing a second isolating breaker which would throw an impedance matched resistor across the synchronous motor terminals. Under this condition, the synchronous motor field would remain excited and the braking current would be induced in the stator. The rotor bars would contribute nothing. It has been felt that emergency stopping such as this is not required on the roughing train because the mill speed is relatively low and slab length short, and any damage that may occur is going to be completed before the mill stands can be stopped. Also for roll changing purposes, this fast stopping time cannot be justified as additional equipment would be involved.

80-IN. ROUGHING TRAIN

The primary difference in this mill over that of the 86-in. is the addition of a vertical edger preceding the roughing scale breaker. This edger is driven by two 500-hp wound-rotor motors running at 514 rpm. See Table VI.

Also a 150-rpm motor was selected for the broadside stand in order to duplicate one that was installed previously at another plant of the same company.

The synchronous motor horsepower and speeds on the remainder of the stands are quite similar to those of the 86-in. roughing train. All synchronous motors have 350 per cent pull-out-torque.

This mill also employs electrical dynamic braking and inching schemes similar to that previously described.

Figure 4 shows the 3500-hp wound-rotor motor

TABLE VI
80-In. mill

Mill stand	Hp	Motor rpm	Mill, fpm	Drive ratio
Vertical edger	2–500†	514	200	30.1
RSB	2000*	150	198	7.5
Broadside R1	3500†	150	201.3	7.67
R2	6000*	240	368	6.5
R3	6000*	360	478	7.5
R4	6000*	360	612	5.71
R5	6000*	360	612	5.71

* Synchronous.
† Wound-rotor.

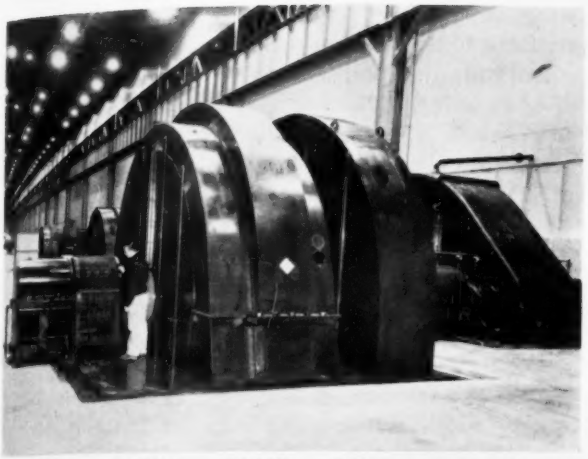


Figure 4 — A 3500-hp, 13,800-v, 148-rpm, wound-rotor motor and flywheel drive broadside stand of 80-in. hot strip mill.

Figure 5 — Four-high universal mill on 80-in. hot strip mill is driven by 6000-hp, 13,800-v, 360-rpm synchronous motors.

driving the broadside mill. Because of its physical size this motor presented a bit of a shipping problem. Various methods of transportation were considered for transporting the rotor unit assembled; even the possibility of shipping it by water down the Mississippi and around the Gulf over to the East coast. That was finally ruled out and it was shipped in two pieces by rail to an Eastern machinery manufacturer where the mill builder's flywheel and the rotor were pressed on the shaft. The stator was split at the horizontal centerline and shipped in two pieces as its over all diameter is 20 ft.

Figure 5 shows a 6000-hp, 360-rpm synchronous motor driving one of the last roughing stands.

SUMMARY

In summing up these three mills, it appears that there is a unanimity of 6000-hp synchronous motors with pull-out-torque of 300 to 350 per cent on all roughers following the broadside stand. The roughing scalebreakers flared widely, but normally range from 2000 to 3000 hp with similar torques. Motors with single reduction gears provided the most economical installation.

On the broadside stands, wound-rotor horsepowers range from 3500 to 5000 with the latter being the mode. In this case, motors with double reduction gears provided the most economical installation. Synchronous motors, if fully applicable, will provide even greater economy.

Inching equipment, and to a somewhat lesser degree dynamic braking equipment, has been considered to be a necessary adjunct.

It is hoped that some of the comments made in this paper will be of value to mill engineers in planning future hot strip mills, whether it be a revamp or a completely new mill.

Discussion

PRESENTED BY

I. N. Tull, Superintendent of Electrical Dept., Cleveland District, Republic Steel Corp., Cleveland, Ohio

J. F. TRENNER, Assistant Superintendent Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

A. F. KENYON, Advisory Engineer Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

JOHN H. GREINER, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. G. COOK, Manager of Industry Engineering, Elliott Co., Pittsburgh, Pa.

J. R. TAYLOR, Steel Mill Application Engineer, General Electric Co., Pittsburgh, Pa.

I. N. Tull: Mr. Greiner looks and talks much happier today than he did when the discussions started some years ago regarding the changeover from a 3000 to 5000-hp motor on a fourth roughing stand drive. His unhappiness at that time was created by the insistence of his customer that the new motor would have to squeeze into the same space occupied by the old one.

As the 3000 had become grossly overloaded due to more tons per hour, it was necessary to make such a replacement, and to avoid a long mill outage time, it was necessary to design the new motor to fit the existing base, without foundation change. As he says, this was accomplished by changing one pedestal and bearing and with some sacrifice of stator shift, by keeping diameters as before, and lengthening the core.

This motor operated successfully four years until it became necessary to meet new demands on the mill, and the other roughing stands all had to have increased driving power, including gearing changes.

As the broadside mill, with flywheels on its pinion shaft could be handled with 5000 hp, it was a natural move to replace its old 3000-hp motor with the 5000-hp on number 4, and put a new synchronous motor on number 4.

In order to be able to draft on the scalebreaker, its 800-hp induction motor and flywheel drive was changed to synchronous, as were the other roughing stands.

Synchronous motors, 6000-hp, with high pull-out torque, were chosen, and it is a tribute to the designers that so little change in foundations was necessary to accommodate those motors. Of course, the scalebreaker stand, changing from 800-hp induction, with flywheels, and complete new gearing, entailed the greatest work.

The turning gears were installed to provide easy breakaway and pod spotting for roll change. Of course this method of jogging does not at the same time provide dynamic braking such as procured by the applica-

tion of low voltage direct current with commutating switches arranged for creeping, but if mandatory, the dynamic braking can be added at quite some expense.

As for putting a synchronous motor on the broadside stand on a wide mill, there are a number of important points to consider beforehand.

Among them are the violent swinging peaks of both kilowatts and kilovars, differences between other motors, their couplings and spare parts, and in an existing mill the very probable lack of space for such a motor.

There is no question as to the savings in kw-hr between induction motors with their flywheels and slip regulators, and synchronous motors, no flywheels or slip regulators. Time will tell the story of maintenance expense ratios, one to the other, and it is well to follow closely the conditions of the synchronous motor field structure to head off trouble before it develops. They are ruggedly built, but they are up against a rugged job and deserve rugged attention.

J. F. Trenner: We at Sparrows Point have used the electrical inching-dynamic braking setup since 1948 with excellent results, very little delay time, and with a minimum of maintenance. We turn our last rougher at an inching speed of about one-and-a-half rpm and stop it as fast as possible to minimize roll change time.

A. F. Kenyon: The author has given an interesting description of the induction and synchronous motor drives and the associated control and auxiliary equipment for the roughing stands of three typical large hot strip mills. From these examples he has generalized and drawn some conclusions as to the apparent trends in the design of such mills and their drives.

We agree with most of his comments. However, if we have correctly identified the three mills which he has described in the paper, both the 86-in. and the 80-in. mills were supplied by the same mill builder, as well as the motor drive equipment by the same electrical manufacturer, so that it is only natural that the motor ratings, gear ratios, mill speeds, and so forth, should be duplicated to a considerable extent, as shown by his Tables IV and VI. However, there may be considerable divergence when comparison is made between mills supplied by different mill builders and to meet the requirements of different steel plants.

In his description of the 98-in. mill, which has been identified by Mr. Tull as the Republic mill at Cleveland, Mr. Greiner describes how the original 3000-hp wound-rotor, induction motor has been replaced by a 5000-hp induction motor on the broadside stand, and a 3000 hp induction motor has been replaced by a 6000-hp synchronous motor on each of stands 2, 3 and 4. From my old records, the broadside and the three roughing stands were originally installed with mill speeds of about 197, 219, 307 and 421 fpm respectively. There has been a recent general trend to operate the roughing stands of hot strip mills at higher speeds, and I would like to ask Mr. Greiner if the gear ratios and mill speeds were kept the same, and if they were changed, what are the new gear ratios and mill speeds.

The author states that for the 86-in. and 80-in. mills described in the paper, studies disclosed that the most economical over-all combination of motor and reduction gear was a moderate speed motor which would permit use of a single reduction gear. Thus the R-2 drive on each mill is a 6000-hp, 240-rpm motor with a 7.84 to 1 ratio gear to the 42 in. diam rolls in one case, and 6.5 to 1 ratio gear to 38-in. diam rolls in the other case.

The R-3, R-4 and R-5 drives on each mill are all 6000-hp, 360-rpm motors, with gear ratios ranging from 7.5 to 1 to 5.7 to 1 to give the desired mill speeds.

Because of comparative costs of wound-rotor and synchronous motors, and the cost of the flywheels, it was found economical on the 86-in. mill broadside stand to use a 5000-hp, 505-rpm induction motor with a double reduction 27.85 to 1 ratio gear to the 42-in. diam rolls.

At this point it may be noted that some mills utilize four-highs for all the roughing stands with work roll diameters ranging from 40 down to 27 in., while other installations use four-highs only for the last two or three roughing stands, and two-highs with rolls usually 42 or 44 in. diam in the earlier stands. Such large roll diameters require either larger gear ratios or lower motor speed to achieve the same mill speed, and the mill design thus will affect the selection of the most economical combination of motor speed and gear ratio, and each project must be evaluated on its own merits.

It will be recalled that a revamped 54-in. mill, some features of which were described in papers at the 1956 AISE Annual Convention, made use of existing 4000-hp, 450-rpm synchronous motors with 23.1 to 1 and 17.3 to 1 ratio gears to drive two-high stands R-1 and R-2, and new 6000-hp, 450-rpm synchronous motors with a ratio of 11.5 to 1, 8.35 to 1 and 7.08 to 1 to drive two-high stand R-3 and four-high stands R-4 and R-5 respectively.

On another 80-in. mill which is now being revamped to enable rolling from heavier slabs and delivery of thinner bar to the finishing train, the scalebreaker will be driven by an existing 2500-hp, 505-rpm wound-rotor induction motor through a gear ratio of about 36 to 1. the 44-in. by 80-in. two-high stands R-1 and R-2 will be driven by existing 4000-hp, 400-rpm and 5000-hp, 600-rpm synchronous motors again through double reduction gears of about 24.3 to 1 and 30.0 to 1 ratio, and the four-high stands R-3, R-4 and R-5, will be driven by new 6000-hp, 600-rpm synchronous motors. The R-3 gear ratio is about 15.7 to 1, the R-4 about 12.0 to 1 and the last stand using quite small rolls has a gear ratio of about 5.6 to 1.

Neither the 54-in. mill nor the 80-in. mill just mentioned has a broadside spreading stand, as the preceding slabbing mills are able to supply slabs up to the maximum width which the strip mill can roll.

The definite trend may be noted, as indicated by the 86-in. and 80-in. mills described by Mr. Greiner's paper and the 54-in. and 80-in. mills which I have mentioned, to have the roughing train consist of five heavy reduction stands in addition to the scalebreaking stand, as compared to most of the earlier mills with only four roughing stands, in order to roll from heavier slabs and deliver thinner bar to the finishing train. Also, there is a very decided trend toward mill speeds of 550 to 600 fpm from the last roughing stand, compared to 400 fpm on older mills, and correspondingly increased speeds on the earlier stands, which is necessary to complete the rolling of the longer, thinner bar in reasonable time and deliver it to the finishing train at the proper temperature.

The author has described the 25-hp slow speed

turning gear equipment which was provided to mechanically position the spindles for roll changing on the drives for the 98-in. mill, also the low frequency jogging and dynamic braking electrical system installed on the 86-in. and 80-in. mills.

It may be emphasized that the turning gear arrangement has advantages that the equipment for different stands is entirely independent so that more than one stand may be jogged simultaneously; and also there is required practically no interlocking to assure protection against faulty operation. It has the disadvantages of a considerable mechanical complication to provide both forward and reverse jogging operation, and that it does not provide any braking for quick stopping. The low frequency jogging and dynamic braking electrical system has the disadvantages of requiring rather careful interlocking and relaying to assure safe operation, and usually the low frequency supply equipment is made of a capacity to enable jogging or braking only one motor at a time. However, it does have the inherent provision for reverse jogging operation and for dynamic braking with practically no additional equipment or complication.

As stated in the paper, some high-speed motors will drift for six to eight minutes or longer before coming to rest, and some mill operators have stated that they consider the dynamic braking provision equally as valuable as the jogging function. The low frequency jogging and dynamic braking electrical system have been included on most of the recent roughing mill drive equipments which our company has supplied.

John H. Greiner: Mr. Tull talked about designers having headaches when they were trying to design a 5000-hp motor to fit in a 3000-hp base. That was nothing compared to what the synchronous motor designer had to do when he tried to put in a 6000. Without exaggerating, one designer actually spent one month in getting that motor to fit in that space and still come up with a 40-degree stator and a 60-degree field.

We had permission, if we could not meet those temperatures, to take a 40-degree stator and maybe an 80-degree field, but we finally made it.

As far as the comments on the broadside mill where the heavy peaks are reflected back on the system, it is true the broadside peaks are slightly higher, but remember in the case of stand No. 4, it is 16,000 hp roughly, and I believe about 17,000 on the broadside, so there is 1000 hp difference, but to me that is one and the same thing. So I would think the peaks in this particular case are virtually the same.

Mr. Kenyon asked if the mill speed on the 98-in. mill was increased. It was just repowered to take heavier slabs and the speeds remained as before.

Mr. Kenyon also talked about dynamic braking and how some operators like the dynamic braking feature. We had a discussion with one steel company, where they did not want dynamic braking on their roughing train because they scheduled their shutdown for roll change in the roughing mill to coincide with the roll change in the finishing mill. In the finishing mill they used two cranes simultaneously so that gave the roughing mill an opportunity to coast to rest.

In Mr. Trenner's plant, their 68-in. hot strip mill has three cranes. They use two on the finishing end and one on the roughing end. Consequently they do not want to wait for the roughers to coast to a stop.

W. G. Cook: The increased slab lengths and improved torque characteristics of synchronous motors made many changes desirable similar to those outlined by Mr. Greiner, and we appreciate the data he has furnished.

Many years ago it was found that the application of large synchronous motors to roughing stand drives of hot strip mills created a serious inching problem. Either full voltage or reduced voltage inching imposed a severe duty on the switchgear and the operation was frequently time consuming. A check on one installation revealed that it was not uncommon for a motor to be jogged more than twenty times before the spindles were set in a position sufficiently accurate to suit the operator.

Since that time, both mechanical and electrical inching systems have been developed which solve the problem with various degrees of satisfactory performance. As a matter of interest, a patent was granted for a successful electrical inching system in 1904. There is at present considerable interest in the subject and it is the purpose of these comments to evaluate some of the outstanding characteristics of the more frequently applied arrangements.

There are two electrical systems which have been considered a standard for a number of years. Each of these incorporate a low and variable frequency three-phase excitation which is applied to the main drive motor stator winding. Typical circuitry and principle of operation have been described by Mr. Greiner.

Each provide an accurate forward and reverse inching control. They require, in addition to a low frequency power generation system, a high voltage isolating breaker which should be mechanically and electrically interlocked with the line breaker, and electrically interlocked with the synchronous motor field contactor or breaker and possibly with a zero speed switch. The isolating breaker interlocking with motor field is important since the synchronous motor, with field applied or decaying, will generate an appreciable voltage which would be imposed on the low voltage components of the low frequency generator system.

The synchronous motor will act as a generator for a considerable period after the field excitation has been removed, and in the interest of safety to personnel and equipment, a separate dynamic braking breaker is recommended where dynamic braking is necessary.

Mechanical inching is not new. A rope wrapped around a shaft or coupling and pulled by a crane—the mechanisms for barring a crankshaft of a single cylinder steam engine over dead center—are common examples. It has been reported that the latter was applied by a local mill to a motor drive many years ago.

The mechanical turning gear for turbines is common practice and this is an application where reliability is most important. In addition to the gear motor, the unit includes an automatic throw out and automatic trip free mechanism where there is no mechanical engagement except when the turning gear is in use.

A modification of the turbine mechanical turning gear, applied as an inching drive for 4000 and 6000-hp synchronous motors was described to the AISE during the 1956 convention at Cleveland in a paper by Kermit Fish and Rodger Shields.

Five such units were built after a comprehensive

Figure 6 — Motor room for a modern continuous hot strip mill with three 6000-hp, and two 4000-hp synchronous motors driving the roughing stands.

study of many possible forms of this method of inching.

They have been in service over two years and provided:

1. Pushbutton controlled forward and reverse inching.
2. Operation with stator shifted, switchgear inoperative or motor windings disconnected.
3. Mechanical trip free operation.
4. No meshing gears or connection with main drive except when inching.
5. Capacity to roll test samples, and assist in backing out cobbles.
6. An assist to the main motor in "break-away" of heavy loads.

The overrunning clutch design described by Mr. Greiner was fully explored and is less expensive, but did not meet the mill "Reverse—Inching" requirement. With the overrunning clutch it is also not possible to jog the motor in reverse by the line breaker without additional mechanical disconnecting means.

There are many smaller applications for inching drives where a less expensive device has been found entirely acceptable. It consists of a standard gear motor, reversing starter and manually operated jaw-type clutch with interlocking to prevent engagement when the motor is rotating and to prevent closing the line breaker when the clutch is engaged.

This system provides pushbutton controlled forward and reverse inching, is completely disconnected from the mill drive in normal operation; is relatively very inexpensive and very simple.

The following figures of typical installations of various inching systems may be of interest and furnish additional background for this subject.

Figure 6 shows a motor room of a modern continuous hot strip mill with three 6000-hp and two 4000-hp synchronous motors driving the roughing stands. The mechanical inching system is coupled to the pinion shaft extension and to the left of the gear unit.

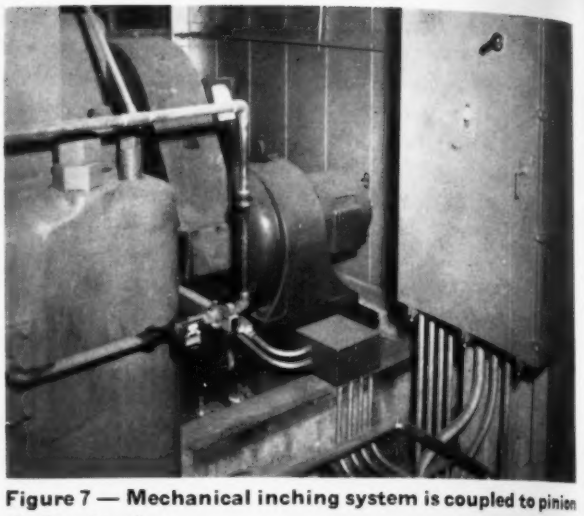


Figure 7 — Mechanical inching system is coupled to pinion shaft extension.

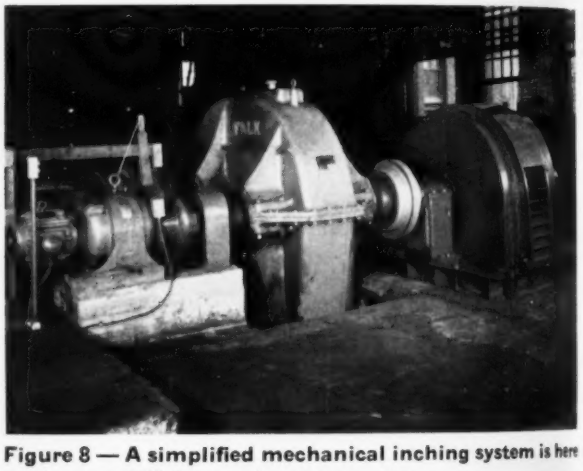


Figure 8 — A simplified mechanical inching system is here used on an 800-hp synchronous motor.

Figure 9 — Mechanical inching system consists of standard gearmotor, reversing starter, manually operated jaw type clutch with interlocking.

Figure 7 is a close up of the mechanical inching drive for one of the 6000-hp roughing stand motors of the hot strip mill.

Figure 8 shows a simplified mechanical inching system applied to an 800-hp synchronous motor and finishing mill train.

Figure 9 is a similar application of the simplified mechanical inching for a 500-hp induction motor drive and breakdown mill.

J. R. Taylor: As Mr. Greiner has limited his paper to three very interesting examples, I believe it would be of

interest to most of us at this time to briefly review the history of hot strip mill roughing drives.

What can be said to be the first hot strip mill was installed during 1926 with a single stand roughing mill driven by a reversing d-c motor having characteristics similar to a blooming mill motor. Power for this drive was supplied by a flywheel-motor-generator set driven by a wound-rotor motor.

Following this installation in rapid succession during the years 1927 and 1928, there were three mills installed with four-stand roughing trains driven by wound-rotor induction motors.

The fourth hot strip mill placed in service had a five stand roughing mill train driven by one synchronous motor and three d-c motors. Shortly after this mill was placed in service, it was determined that the synchronous motor rating was inadequate and it was replaced with a d-c motor.

This mill was followed by two other mills during 1930 with four-stand roughing trains, utilizing d-c motor drives. Following these mills with d-c motor drives were two or three other mills with four stand roughing trains with wound-rotor motor drives.

This brings us up to the year 1932 when there was installed in the Pittsburgh area a mill with a three-stand roughing train, each stand being driven by a synchronous motor. To the best of my knowledge this was the first all-synchronous motor driven hot strip mill roughing train.

Following this installation there were some 12 mills installed, ten of which used roughing mills driven by wound-rotor induction motors while two used single stand universal roughers driven by reversing d-c motors. In 1937, a mill with a four-stand roughing train was installed with all synchronous motor drives. From then on to the present date, we find increasing use of synchronous motors, and d-c reversing motors supplied by synchronous motor-generator sets, for rougher drives.

In the early stages of the hot strip mill, slab weights were in the order of 200 lb per in. width and perhaps less, resulting in the roughing mill pass duration being relatively short. This made the application of flywheels and wound-rotor induction motors a very useful tool to limit the demand peaks on the power system. Slab weight per unit width has increased to something in the order of 715 lb per in. width. The pass time in the roughing mill stands has become of such duration that flywheels have been rendered useless and has in many cases dictated the application of synchronous motors for these drives.

Considering this increase in slab weights, let us take a look at the change in some of these existing mills that were installed in the early years. The mill installed in 1926 with a universal rougher is operating today in almost its original form. The second mill which had wound-rotor motor drives has been revamped to a modern five-stand roughing train using synchronous motor drives and perhaps utilizes the heaviest slab weight per unit width of anywhere in the industry. The mill which I referred to with a d-c motor driven roughing train has gone through some changes. However, the roughing train remains essentially in its original form, except control equipment has been provided to operate the roughing stands at maximum speed until the head end of the slab approaches the first stand of the finishing train at which time the roughing mill drives are automatically decelerated to synchronize with the finishing mill. Slab weights are such that metal is in the finishing mill and one or more roughing stands at the same time. To the best of my knowledge this operation has produced satisfactory results. With reference to the mill installed during 1932 with the first synchronous motor driven roughing train, this mill since World War II has been completely revamped and now utilizes a single-stand universal rougher. Many of the roughing mills which were originally installed with wound-rotor induction motors have been modified in some manner or other, having one or more of the stands driven by synchronous motors. Mr. Greiner's paper covered in detail a very excellent example.

Many mills have selected the application of the synchronous motor on continuous roughing trains. However, it is interesting to note that there is a growing tendency to apply universal roughers in some new hot strip mills. It is very possible that the increased slab weight will perhaps make the universal rougher a very flexible, useful tool as well as perhaps being favored economically.

Many factors such as available power supply, maximum demand cost, slab weight per unit width, total production required, type of product and economics will dictate the choice of various combinations of wound-rotor induction motors, squirrel-cage induction motors, synchronous motors, d-c motors and universal rougher drives for the future hot strip mills. We can visualize even a possibility that a hot strip mill roughing train would be made up of two universal roughers with card program control on which operators would not be required in the same manner as they are today.

There is often a question concerning the selection of motor pull-out torque rating when applying synchronous motors to roughing mill drives. It has been our experience that approximately 300 per cent pull-out torque is about the maximum economic limit. In some cases, a better selection would be a higher rms rating with a pull-out torque lower than 300 per cent, still answering the requirements of total torque. This selection would favor a heavier duty cycle where a greater rms horsepower is required with the use of heavier slabs.

Regarding the use of dynamic braking where synchronous motor drives are applied, it has been our experience that the most common choice is the regeneration method, using a resistor load across the stator phases and exciting the motor field. Mr. Greiner's paper described a method of dynamic braking in which the stator winding is excited with a low voltage direct current, using the squirrel-cage field winding to produce the regeneration torque. In either case the high voltage breaker equipment is the same. Before closing, we would like to ask Mr. Greiner what methods they have utilized for detecting essentially zero voltage on the stator winding or indicating that the d-c field has decayed before allowing the breaker to close—connecting the low voltage d-c machines across stator winding?

John H. Greiner: Concerning Mr. Taylor's question, we have a timing relay, the adjustment of which is based on the time constant of the synchronous motor field. This relay is energized by the synchronous motor field contactor opening and after the required delay it brings in the low voltage equipment. ▲

Magnetic-Flux Gas Shielded

. . . .new welding process has advantages of ease of operation, high speed, high current input, limited spatter, and high quality . . . .

by J. E. Dato,
Manager,
Eastern Region—Electric Welding
Linde Co.
Div. of Union Carbide Corp.
New York, N.Y.

ALTHOUGH there are many good processes for welding carbon steel, there is a broad area that is not adequately covered by these methods, from the standpoint of highest possible quality at the lowest possible cost. This area is the field between manual-covered electrode welding and fully automatic production units.

To fill the need in this field of welding, our laboratories have during the last five years worked on a joint effort. The result was the development of a magnetic-flux gas-shielded arc welding process that produces high quality welds in mild steel at greater welding speeds and lower welding costs than covered electrodes.

The process was introduced April 9, 1957 at the American Welding Society Annual Meeting and Exposition in Philadelphia. Prior to this, one and a half years of testing on the production line was done in a selected metal fabricating plant so that experience could be gained with respect to refinements in the process and the equipment.

PROCESS DESCRIPTION

Essentially, the components of magnetic-flux gas-shielded arc welding are: bare welding wire, magnetic flux, carbon-dioxide gas and welding current. Figure 1 shows these components in schematic form. During welding, flux propelled in a gas stream and the wire are

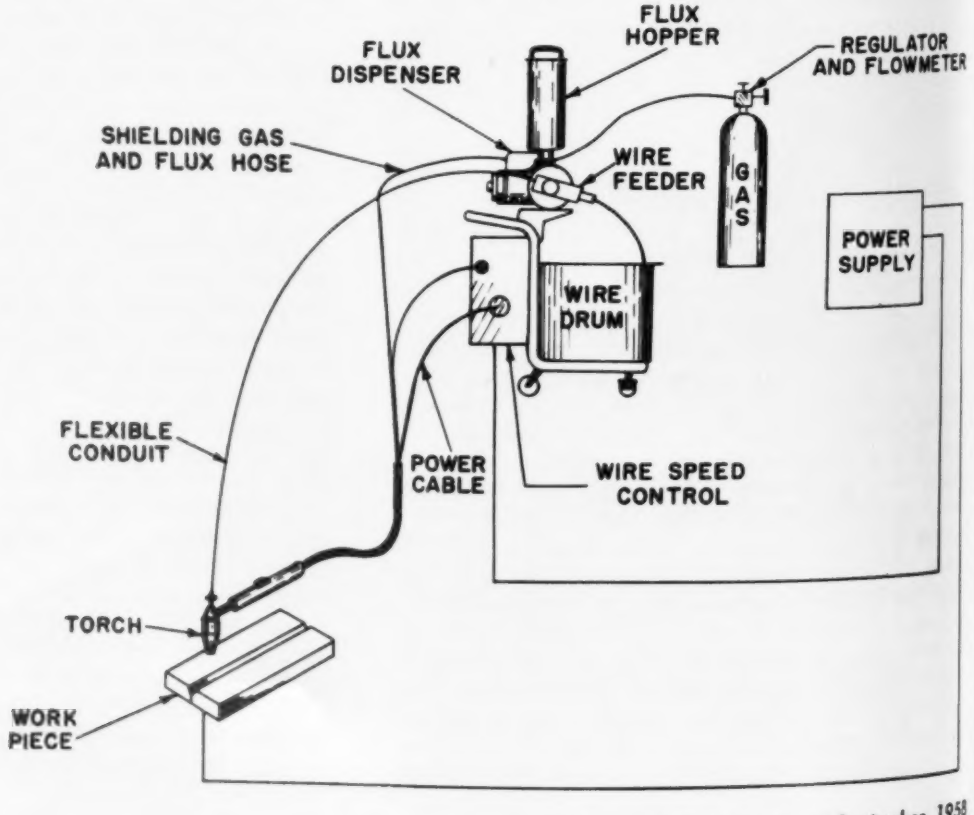


Figure 1 — Schematic diagram of apparatus shows equipment and accessories employed with new method.

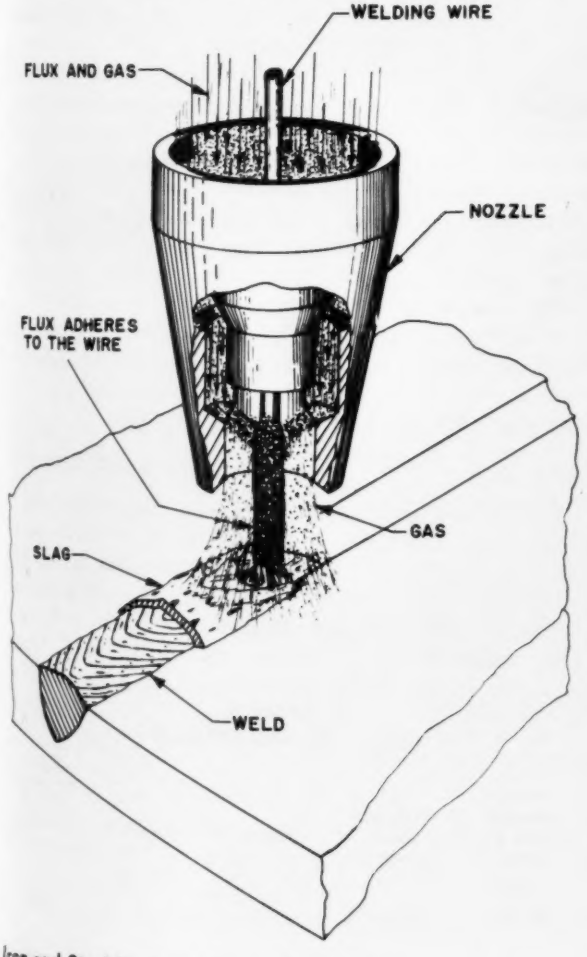
Arc Welding

fed simultaneously to the torch. At the torch nozzle, the welding current flowing through the wire establishes a magnetic field that attracts the magnetizable flux to the wire (Figure 2). As a result, the electrode or wire is "flux-coated" as it enters the arc. The flux performs three main functions: it stabilizes the arc, refines and protects the weld puddle, and controls weld contour and coalescence. Besides conveying the flux to the torch, the carbon dioxide gas also provides supplementary shielding, and in combination with the flux gives desirable arc characteristics.

These arc characteristics are similar to those of covered electrodes, and can be very readily learned by the average welding operator. In fact, since the wire is fed automatically by the welding machine, manual skill requirements for downhand welding are less than with covered electrode welding, and the process can be learned more quickly.

Current densities are generally higher than with covered electrodes. Metal transfer is of a "spray type" and very little spatter is evolved. The small amount that does occur is not tenacious and can be readily removed by wiping or light brushing.

Figure 2 — The flux is attracted to the wire by the magnetic field surrounding the wire when welding current flows.



EQUIPMENT

The complete machine is shown in Figure 3. The equipment used is somewhat similar to other semi-automatic welding machines. The coiled wire is contained in a cardboard drum and is fed to the torch by an electronically controlled drive unit. This unit is directly coupled to the flux dispenser, so that the flow of flux is always

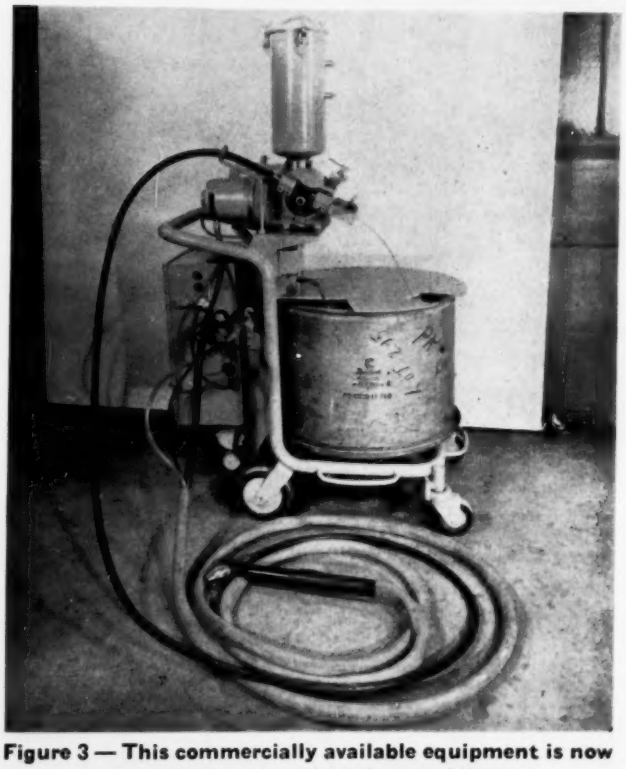


Figure 3 — This commercially available equipment is now used for magnetic-flux gas-shielded arc welding.

Figure 4 — Operator adjusts flux feed rate by rotating the hopper. An easily-read dial indicates the flux-to-wire ratio.

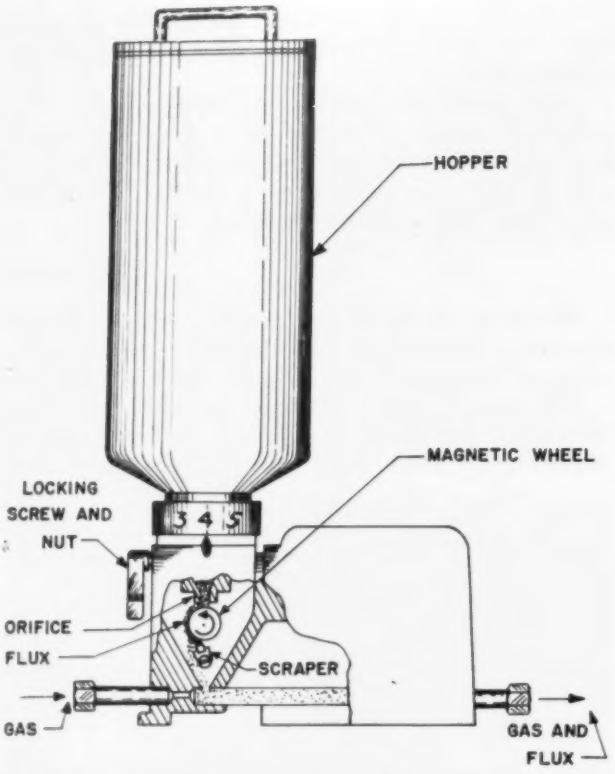


Figure 5 — Flux dispensing mechanism meters flux into the gas stream. The magnetic wheel is directly connected to the wire feed drive unit.

proportional to the wire feed. The desired flux-to-wire ratio is set on the flux dispenser shown in Figure 4. The bare wire is fed through a 16-ft long flexible conduit and the flux, metered to the proper proportion, is fluidized by the carbon dioxide gas stream and conveyed through a hose to the welding torch. Figure 5 shows the flux dispenser and the method of metering. The wire, flux and gas are brought together for the welding operation through the air-cooled torch, shown in Figure 6. A constant potential d-c power source is generally used; however, conventional drooping characteristic power supplies can be used for many applications, particularly when high welding current densities are used.

PROCESS APPLICATION

Welds can be made in all positions with this new process, but lower current densities and greater operator

Figure 6 — Welding is started and stopped by the switch on torch handle.

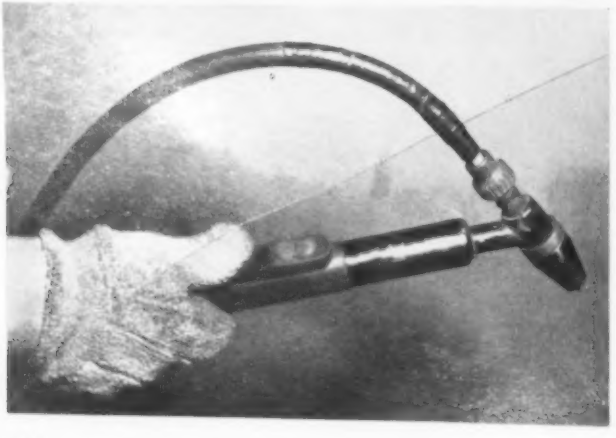


Figure 7 — Butt weld was made in ¾-in. thick material using one pass from each side at 425 amp. No back-chipping is required.

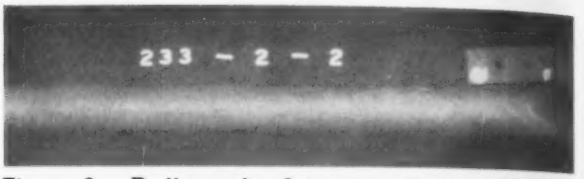


Figure 8 — Radiograph of two-pass butt weld made in ¾-in. thick A285 steel plate.

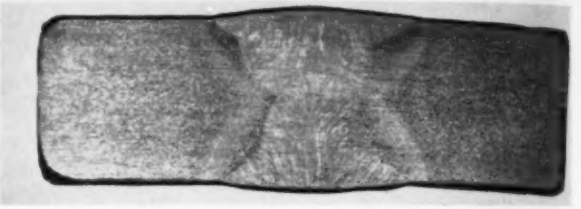


Figure 9 — Etched cross-section of butt weld.

skills are required when welding in the vertical and overhead positions as compared to flat and horizontal welding. Two wire sizes $^{3}/_{32}$ and $^{3}/_{64}$ in. in diameter cover a wide operating range and the equipment is designed around these two sizes. Generally speaking, the larger wire is used for flat and horizontal positions, while the smaller wire is used in all positions—flat, horizontal, vertical and overhead.

For higher current density welding in the flat and horizontal positions, $^{3}/_{32}$-in. diam wire is used in a current range of approximately 350 to 500 amp direct-current, reversed polarity with a flux-to-wire ratio of ½-lb of flux to one lb of wire. These conditions are particularly successful in fillet welding; high speeds are obtained with no undercutting. The process will also give excellent results with butt welding, a double bevel edge preparation being generally recommended.

On all position welding, $^{3}/_{64}$-in. diam wire is used with welding currents varying from 125 to 250 amp direct current, reversed polarity. Flux-to-wire ratios are in the range of 0.3 to 0.6 lb flux per lb of wire.

WELD QUALITY

In the development and testing of this process, welds of all types were made on steels conforming to the most common ASTM classifications such as A283, A285, A7, A212 and A201. Figure 7 shows a butt weld prepared in the horizontal position with one pass from each side. The welds made exhibited excellent quality and

TABLE I
Typical Mechanical Properties

Yield strength 0.5 per cent offset, psi	Ultimate tensile strength, psi	Elongation per cent in 2 in.	Reduction of area, per cent	Charpy vee notch, 15 ft-lb transition temperature F
66,000	78,000	28	65	−40

easily met radiographic requirements of paragraph UW51 of section VIII, ASME boiler and pressure vessel code. Figure 8 shows a radiograph of a two-pass butt weld made in ¾-in. thick A285 steel plate. The plates welded in these tests were covered with either normal mill scale or rust and plate edges were prepared by oxy-acetylene cutting. There was no special preparation such as grinding or brushing prior to welding. Excellent penetration was obtained, as can be seen in Figure 9. Slag was easily removed.

MECHANICAL PROPERTIES

Standard side, root and face bend tests have indicated that welds made with this process have satisfactory soundness and bending qualities. Typical mechanical properties of magnetic-flux gas-shielded arc welds are given in Table I.

COMPARISON WITH COVERED-ELECTRODE WELDING

Mechanized continuous wire feed and high current densities result in high deposition rates—generally twice the rate of E6012 electrodes and about one and one-third times the rate of E6024 electrodes. A comparison of deposition rates is shown in Figure 10. Figure 11 shows a comparison in welding speeds. Easily obtained in shop practice, these rates are for downhand welding, but indications are that deposition rate advantages are even greater when welding in the vertical and overhead positions.

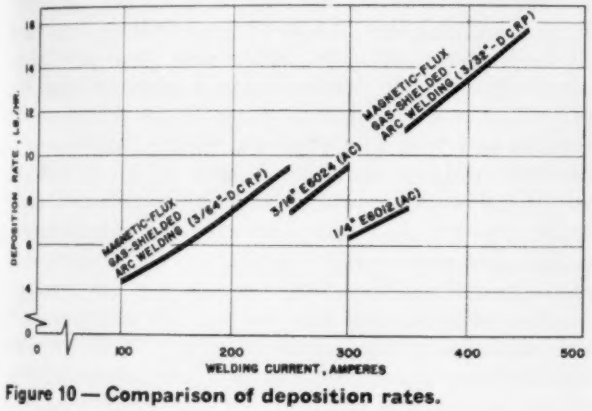
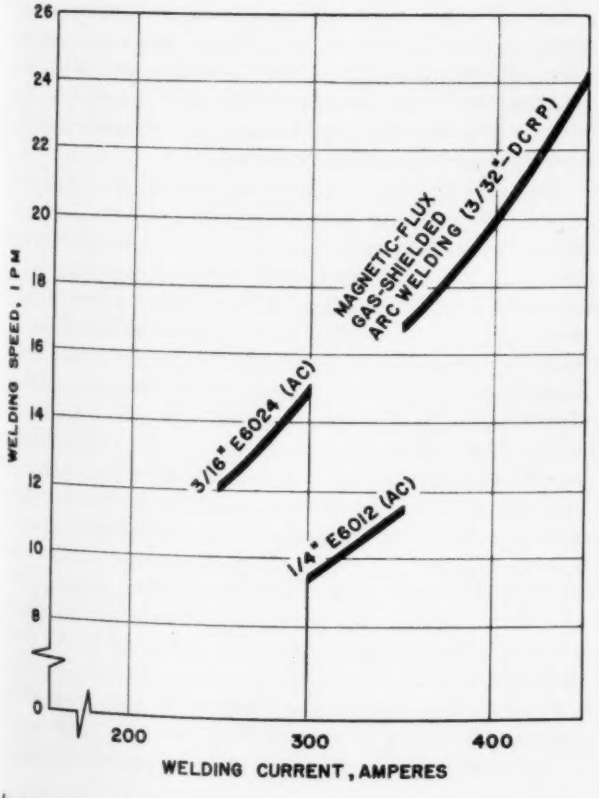


Figure 10 — Comparison of deposition rates.

Figure 11 — Comparison of welding speeds for ¼-in. fillet weld.

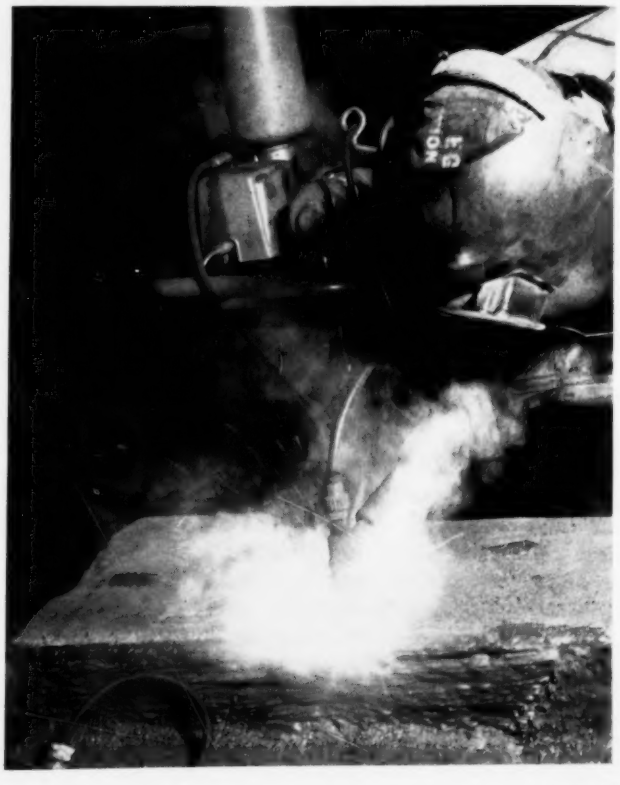


APPLICATIONS

Many applications are being found for this new process. Its advantages of high speed ease of operation, high current input, limited spatter, and high quality make it especially adaptable to operations such as the fabrication of earth moving equipment, oil field equipment, pipe welding, field storage tanks, casting repair, bridge girders and railroad car fabrication. Figures 12 and 13, illustrate some of the applications of magnetic-flux gas-shielded arc welding in industry.

Figure 12 — Casting for rock crushing equipment is being built up.

Figure 13 — Deposit rate is 7 to 7½ lb per hr.



Discussion

presented by

JAMES H. DILLON, Supervisor
Building Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. E. DATO, Manager,
Eastern Region-Electric Welding, Linde Co., Div. of Union Carbide Corp., New York, N. Y.

D. W. PEHL, Superintendent,
Mechanical Maintenance, Kaiser Steel Corp., Fontana, Calif.

R. A. KRAUS, Superintendent,
Mechanical Maintenance, Republic Steel Corp., Chicago, Ill.

KENNETH HUNT, Superintendent,
Construction Maintenance and Shops, Crucible Steel Company of America, Midland, Pa.

JOHN MARTA, Sales Manager,
Canadian Liquid Air Co. Ltd., Hamilton, Ontario, Canada

JAMES P. KINNEY,
James P. Kinney Co., Los Angeles, Calif.

EVERETT HITE, Assistant Superintendent of Maintenance, Steel and Tube Div.,
The Timken Roller Bearing Co., Canton, Ohio

James H. Dillon: The welding process described would seemingly have many advantages combining as it does the automatic welding and also the flexibility of the manual process. A statement was made to the effect that this process would approximate half the cost of manual arc welding—I am assuming a comparable quality of weld. I would ask Mr. Dato if that cost included the gas and the magnetic flux.

A further question that intrigues me is that of operator fatigue, particularly in the overhead and vertical position. I believe we can readily understand that such a process would lose its merit if the operator were not able to continue it on a pretty constant basis. I wonder if Mr. Dato could give us any information in that respect. Operator fatigue, as I say, intrigues me. What little experience I have had would lead me to believe that holder or torch might be a little cumbersome or possibly heavy, particularly when welding overhead or vertical.

Another thing I would like to mention does not concern production welding as much as it would maintenance welding. In maintenance shops we have a large and continual variety of jobs—sometimes they fall over one another coming into the shop.

In the manual process we have a current to regulate or adjust for the various jobs and that is about it. In a process such as Mr. Dato has described, we have, of course, the welding current to regulate. We also have a number of other variables, which are gas pressure, the feed of the rod, the amount of the flux on the rod, and I am wondering how critical each one of those factors is with this idea in mind, that, for a great number of vastly different jobs, if those various factors or adjustments are critical then the adjustment for the individual job would be a matter of some considerable time and trouble. In other words, we all know processes that are excellent in themselves, but actually give us more time and trouble getting set up to do the work than they benefit us in the actual doing of the job.

J. E. Dato: First, with respect to cost, the cost figures that were used and the comments about them relate to work on which the equipment is used to its full advantage. If you do not operate a tool of this type or any mechanized or semi-mechanized piece of equipment at relatively high duty factors, you cannot show favorable costs. So that is a must with the tool; if you are going to have efficiency from it, it must be used at reasonably high duty cycles. You then get the end result that you are after—lower cost welds. It does produce quality welding. You were asking for cost comparison, and the cost mentioned did include the cost of the gas and the flux. It also included the cost of the wire, and I mentioned the cost of the wire because wire of small diameter is fairly high priced.

Needless to say, a piece of equipment of this type costs money as compared to a stick electrode holder, so that your investment is greater. We do have to get greater efficiency, greater deposition rates, in order to justify those additional costs.

Your second point was operator fatigue. You are correct in saying that this tool is heavier than a standard electrode holder. Working in the downhand position as you suggested, Mr. Dillon, is not a great problem. We find that it works very well there. As you work into the vertical and overhead position, weight does become a problem and we have recognized it. We are doing additional work on torches to produce a lighter, more easily handled piece of equipment. One way, obviously would be to water cool the apparatus. But we decided to avoid that if at all possible because it would introduce another element into the process. We think we have the answer in a new torch. Of course, it will be some time before it is out as a standard tool, but we feel that we are on the right track.

As to using the equipment in maintenance operation, there are some adjustments to be made, but you will notice that the current range was reasonably broad, and it is not too critical with respect to the use of the process. Also, gas flow, once it is set, is pretty much a constant. As you change wire feed speed, the flux ratios being set the way they are and coupled with the wire feed speed, remain constant.

The only real adjustment that you have is changing this welding wire speed through the use of a potentiometer which controls the speed of the wire feed motor. Since the process is used with constant potential types of power source, changes in wire speed automatically alter the current to give you the meltoff rate required for the additional wire feed speed. So unless you change from one wire size to another, or the operation is very drastically changed, there is very little adjustment to be made from one weld to another. Where you would go from $\frac{3}{64}$-in. wire to $\frac{3}{32}$-in. wire when you want to weld overhead in one position, downhand to another; then that would be a considerable change, no question about it. Again, if you cannot use the tool at relatively high duty factors, the time and trouble, as you mentioned and setup, would certainly defeat the purpose. That type of operation would not be the place for this tool.

We would not want to represent this method of welding as being a cureall, but it does have many applications, and, properly applied, you will get high

quality welds at a high deposition rate at low cost, when you figure your labor, overhead and cost per pound of metal deposited.

D. W. Pehl: The slag is magnetically attracted to your electrodes, which would indicate a ferrous material in the flux. Your welds look beautiful in the illustrations, but I was wondering if you had any problem of slag inclusion because of my assumed ferrous materials in the flux.

I assume, using the rectifier type welding machine, that you have arc control with the electrode so that it does not stick at any time.

I further wondered if a normal qualified welder could readily adapt himself to this machine, particularly for the vertical and overhead working, and using the higher currents as you were using—if there would not be a tendency to undercut in the welds.

I would also like to know the general cost of this machine, roughly, and what the normal day's consumption in the inert gas, CO_2, would be.

J. E. Dato: Mr. Pehl, your assumption of ferrous material in the flux is correct. The flux is 30 per cent iron powder and it is bonded to the flux particles. It is a very fine powder, 200 mesh size, as you saw the operator pouring it into the flux hopper. That iron powder ends up in the deposited weld metal. The flux that is removed from the top of the weld that solidifies on the completed weld does not have any substantial amounts of iron left in it, similar to the iron powder electrode idea in effect.

As to the rectifier type machine, that was a constant potential rectifier in the movie; motor-generator sets will do a very satisfactory job. Also, as pointed out in the discussion, the standard drooping characteristic machine will work satisfactorily. The constant potential source of power has a couple of advantages, first, in the very high current surge that you get in starting the arc so that you get easier starting characteristics with that type of power supply. Second you have built-in current changing characteristics as wire feed speeds would be changed, you set a voltage condition and it stays constant. These features of the machine adapt themselves well to a constant wire speed process such as we have here. So because of these features there is less adjustment, in the setting up of the equipment, using a constant potential type of power source as compared to a conventional drooping characteristic machine.

You are correct in your assumption that welding vertically and in the overhead position are more difficult for the operator than downhand welding. It requires more training for the operator to use the process in these positions. That is equally true of other welding processes. We have taken arc welders that are good downhand welders, and put them on vertical and overhead welding with this process and it takes some training. You take an operator that is good on vertical and overhead work with ordinary arc welding and he readily adapts himself to this process and does a good job.

As for undercutting with high current densities, it is true that undercutting the top leg of a fillet in the flat position would appear to be a problem. It is the nature of the process however that we get very good washing of the material up on that upper leg of the fillet and there is actually a minimum amount of trouble so far as undercutting is concerned.

As to general costs, the machine itself is in the neighborhood of $2200 to $2500 give or take a few dollars. That is the range, and of course the power source on top of that, depending on the size, would be another $1200 or so. We are looking at something on the order of $3500 in round numbers for a complete package.

Gas consumption is at the rate of approximately 30 cfhr. Weld deposition can be up to 15 lb an hour.

We have some users—one I have in mind right now—that actually achieve 13- to 14-lb deposition rate per hour in the repair of steel castings. They operate the machine between two operators. While one is setting up a job, the other operator is running the machine, and they get 92 to 93 per cent equipment duty factor on this basis.

R. A. Kraus: Do you have a cost figure per pound of deposited metal, including flux and gas, but eliminating the operator cost?

J. E. Dato: Yes. The flux, one thing that has not been mentioned, is about half a pound of flux per pound of wire deposited. That would be 17½ cents. The wire is about 15½ cents in the $\frac{3}{32}$ in. size. There would be a gas cost of about 1½ or 2 cents and there would be 2½ cents a pound royalty in the licensing arrangement. That comes to about 37½ cents per pound of metal deposited.

Actually, that would deposit over a pound because of the iron powder that you would pick up.

Kenneth Hunt: Have you had any experience in rebuilding or in the use of this welding in railway cars?

J. E. Dato: With respect to car operation, to my knowledge the only thing that we are working on at the present time in cars is fabrication of new cars. There is a company in the Pittsburgh area that is working on $\frac{3}{8}$-in. thick material in the fabrication of cars and using the process, but not in repair. I see no reason why we would not get ultimately into that type of operation.

John Marta: I was wondering if you mentioned d-c rectifiers only. There was no mention of a-c machines.

J. E. Dato: With respect to the use of a-c equipment it can be used but the operation is not as stable. In the arc outages that occur from one cycle to the other, you get some instability and you get more spatter in the operation, so that we find d-c is the preferable current to use. A-c will work, of course. There are some other gases that will work, but to get the most economical operation, CO_2 is the gas to use. As a matter of interest, using argon, the arc quiets down very nicely with a-c, but in buying argon, it is not offset by savings that you would make in using a-c current.

James P. Kinney: In replacing the expended wire, is that done in the drum? Does it come in a replaceable container?

J. E. Dato: On the machine that you saw here, there was a drum of wire which is shipped in that drum. As you use the wire you empty the container and then dispose of it.

Everett Hite: Quite often on repair jobs it is necessary to make a heavy weld which cannot be stress relieved. Does this process offer any advantages which would reduce the necessity of stress relieving, particularly on heavy deposits?

J. E. Dato: I cannot answer your question directly. I do not think so. ▲

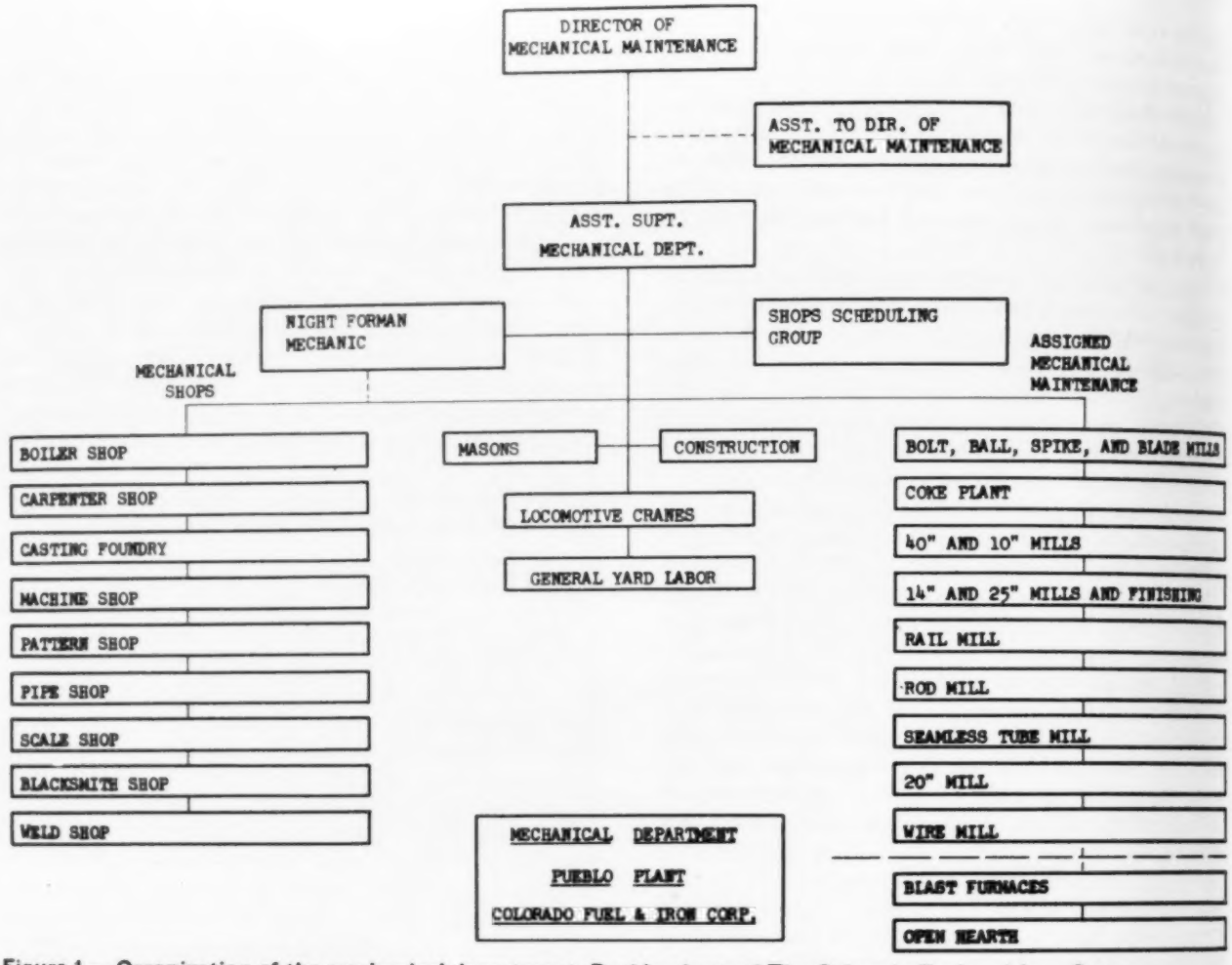


Figure 1 — Organization of the mechanical department, Pueblo plant, of The Colorado Fuel and Iron Corp.

"It Ain't Mechanical"

by Jerome L. Lindberg,
Assistant to Director Mechanical Maintenance
The Colorado Fuel and Iron Corp.
Pueblo, Colo.

. . . successful maintenance has as its purpose reduction of operating costs through reduced breakdowns, increased productivity and improved product quality . . . . well trained men, under good supervisors, are essential for this objective . . . .

NOTWITHSTANDING widely expressed opinions to the contrary, the author would like to advance the concept that a mechanical maintenance group is made up of human beings. Surely these individuals so frequently maligned and misunderstood are as vulnerable to the "Thank God it's Friday" emotion as their more glamorous friends, the operating crews (although it has been traditionally convenient to insist that all maintenance be performed on night shifts, week-ends and Christmas). Even more understandable is the audible sigh of relief a mechanical supervisor could express when told that his mill is down, but that "it ain't mechanical." Understandable, yes, but permissible under today's automated processes and interrelated equipment—certainly not! Maintenance, always a key function in any integrated steel mill, has become, in many instances, the deciding factor in the success or failure of an otherwise profitable installation.

There was perhaps a time during the "sledge-hammer era" that maintenance men could adopt the attitude of an ostrich when contemplating problems not strictly attributable to their scope of activity. The happy sound of "it ain't mechanical" could have the immediate effect of unconcern and indifference towards problems confronting the electricians, operators, quality control inspectors or any other group sweating out a production stoppage. This attitude, although easily understandable and even tolerated, could never remain unchallenged in today's highly competitive business world; and the challenge, when it came, resulted in a re-evaluation of the primary responsibilities confronting a modern maintenance organization. These responsibilities must, of course, be guided and defined by the basic objectives of improving productive output and quality of product in addition to reducing operating costs and preventing breakdowns.

The carrying out of these responsibilities, however, brings us back to a discussion of a maintenance group composed of people. Not just people in general, but specific kinds of people—skilled in their jobs, organized efficiently and led by capable supervisors. To become even more specific, the author would like to relate the execution of these primary responsibilities to the organization of the mechanical department at the Pueblo plant of The Colorado Fuel and Iron Corp.

An extension of these primary responsibilities is necessitated, however, due to the remote location of the plant with respect to other heavy industry, equipment manufacturers and sources of well-trained personnel required to meet operating demands. The more important of these additional functions would include the following elements to be performed wholly or in part by the department:

1. The manufacture of virtually all spares used throughout the mill.
2. The fabrication, construction and erection of new mill equipment and facilities.
3. The stock piling and bulk loading and unloading of basic materials in the plant.
4. The training of all necessary personnel without dependence upon outside sources for skilled employees.
5. The use of the shops to provide services for other plants within the corporation.
6. The design and development of new equipment, techniques and processes in conjunction with engineering and operating departments.
7. Participation in actual production work where such work can best be performed by shop's personnel and equipment.
8. Providing inspection, maintenance and repair services needed at remote installations of the corporation not served by an integrated maintenance group.

The department is charged with an over-all responsibility for all mechanical maintenance encountered in the plant which, of course, includes all factors mentioned above. In order to carry these out to the best possible advantage, an organization has been developed that, although retaining an integrated structure, subdivides the group into three general categories; namely, the mechanical shop units, the assigned maintenance units, and the construction, bricklaying, locomotive crane and labor units. Under normal operations, the department employs approximately 1250 men which is roughly one employee out of every seven within the plant.

The over-all composition of the mechanical department is shown on Figure 1. Heading the departmental functions are the director of mechanical maintenance, the assistant superintendent of the mechanical department, assistant to the director of mechanical maintenance, a night foreman mechanic and a shops scheduling group.

Specific mention of the shops scheduling group would be in order before going into the operation of individual units within the department. This group, composed of men selected for ability, background, technical knowledge and temperament control construction and maintenance schedules throughout the entire plant. They process all orders going through the mechanical shops, scheduling work from the standpoint of time, machine and process. To do this, it is necessary, in addition, that they be responsible for the adequacy of material inventories, the co-ordination of outside purchased material deliveries with shop schedules, and the maintenance of a spare parts record system. Master files kept in their office contain detailed information on virtually all operating parts required in the plant, and in addition, provide a constant record of all material stocks processed by the shops units.

Such scheduling and record keeping is, however, primarily clerical in nature and constitutes only a small part of the over-all responsibility of this group. All too often revisions or corrections have to be made on many orders prior to their release to the shops. To accomplish this, each order is examined very carefully and such savings as the use of standard items and available material or the occasional deletion of unusual "contraptions" are effected. This should not be construed as belittling the engineering department, with whom the shops work very closely. In fact, many orders intercepted by this group are sent directly to engineering for approval or redesign before placement on shop schedules. Such close scrutiny does, however, provide an excellent check-and-balance to reduce unnecessary work eliminate duplication of orders, and minimize delays caused by unavailable material or equipment. This function ably illustrates a responsibility not strictly "mechanical" in nature, but obviously best performed by the staff of the mechanical department. It is equally obvious that accident prevention, cost reduction, quality of workmanship and sustained production derive benefits from such careful appraisal of all work ordered through the shops.

Figure 2 presents the organization of the mechanical shops units indicating supervisory coverage, craft participation, apprentice training and total employment of each shop. It would be virtually impossible to overemphasize here the reliance placed upon this group of people, from unit supervisors down through the craftsmen and position-rated employees. In most instances shop foremen have been promoted from the ranks within their units and have proven very capable of conducting their work in an efficient manner. Participation by top department supervision is held to a minimum and is limited primarily to matters of labor relations and the

BOILER SHOP	
GENERAL FOREMAN 3 ASST. FOREMAN	
CRAFTSMEN	45
APPRENTICES	6
MISC.	80
SHOP TOTAL	131

CARPENTER SHOP	
GENERAL FOREMAN	
CRAFTSMEN	18
APPRENTICES	2
MISC.	2
SHOP TOTAL	22

CASTING FOUNDRY	
GENERAL FOREMAN 5 ASST. FOREMAN	
CRAFTSMEN	44
APPRENTICES	5
MISC.	95
SHOP TOTAL	144

MACHINE SHOP	
GENERAL FOREMAN 2 ASST. FOREMAN	
CRAFTSMEN	76
APPRENTICES	16
MISC.	42
SHOP TOTAL	134

PATTERN SHOP	
GENERAL FOREMAN	
CRAFTSMEN	8
APPRENTICES	1
MISC.	7
SHOP TOTAL	16

PIPE SHOP	
GENERAL FOREMAN	
CRAFTSMAN	8
APPRENTICES	3
MISC.	11
SHOP TOTAL	22

BLACKSMITH SHOP	
GENERAL FOREMAN	
CRAFTSMAN	6
APPRENTICES	2
MISC.	13
SHOP TOTAL	21

WELD SHOP	
GENERAL FOREMAN ASST. FOREMAN	
CRAFTSMAN	46
APPRENTICES	6
MISC.	28
SHOP TOTAL	80

SCALE SHOP	
ASST. MACHINE SHOP FOREMAN	
SHOP TOTAL	6

TOTAL SUPERVISION ---- 20

TOTAL EMPLOYEES ---- 576

Figure 2 — Extensive mechanical shop units are set up at this plant.

over-all discussion of large or intricate projects before the inception of such work.

A tremendous amount of assistance is received from shop supervisors in developing new equipment, changing existing designs and utilizing available materials to take care of emergency situations. The old anecdote concerning the engineer who resorted to wearing rubber gloves because of a leaking fountain pen is not particularly humorous when applied to everyday mill operations. One of the responsibilities of all mechanical department supervisors is to be on the alert for and prevent any "rubber-glove engineering" on the part of operating personnel.

Accident prevention in the shops as in the entire department, has always been given a great deal of emphasis. This work has been directed primarily at the education of each employee in the safe conduct of his job and then insisting that these instructions be followed implicitly. A great deal of work is also done in each of the various units to maintain good housekeeping, to provide continuous safety inspections, and to investigate thoroughly any accident that does occur. In line with this, it has been found highly beneficial to stress the importance of the near misses; those accidents which but for pure luck could have had extremely serious consequences.

As was pointed out previously, the remote location of

Figure 3 — It is difficult to keep spares for units such as this 12,000-hp reversing steam engine.

Figure 4 — A 112-ton frame was made for rail mill blooming engine base.

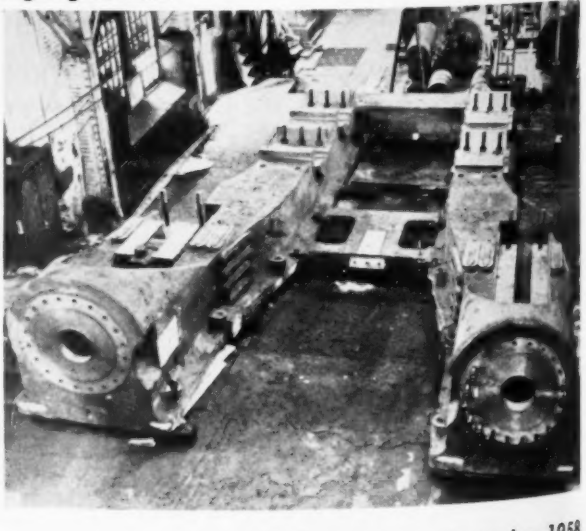


Figure 5 — A permanent mold is used to cast slag pots.

the plant makes it virtually impossible to obtain skilled craftsmen from outside labor markets. For that reason, it has been found necessary to develop procedures within the shops organization to train and promote required personnel. The organization chart indicated an apprentice program with extensive coverage in the shop units. Since the adoption of this program in 1948, 93 men have completed their apprenticeship in the 12 trades under mechanical department jurisdiction, and there are at present, an additional 64 men currently undergoing this training. The department is justifiably proud of the fact that less than 7 per cent of the men completing their apprenticeship have left the company for employment elsewhere. Regular shops helpers and position rated employees have never been denied the opportunity to promote to a craft status; their own knowledge and ability being the basic prerequisites of this promotion. It is insisted, however, that they must be able to pass written examinations on trade knowledge and then prove conclusively on the job that their skills are commensurate with those acquired through the apprentice program.

By accepting the responsibility of spare parts fabrication, the shop units have been able to develop many money saving techniques in mill maintenance. A typical example would be the procedure used in maintaining a spare cylinder for the 40-in. mill blooming engine. The engine, shown in Figure 3, is a 2-cylinder, 55-in. bore x 60-in. stroke reversing steam engine developing 12,000 hp. Engines of this type are subject to connecting rod and piston failures which can result in a thoroughly wrecked cylinder. Inasmuch as the engine is about 55 years old and the largest of its type west of the Mississippi, the lack of readily available spares can be appreciated. Were it necessary to purchase these cylinders from an outside source, two spares would have to be carried on hand at all times in the event of failure of either the right or left hand cylinder. Instead, one spare cylinder is cast and semi-finished to the extent that by further machining, it can be adapted to either side of the engine in the time required to disassemble the old cylinder.

Some further illustrations of the type of work handled with the shops units are given in the following examples:

Shown in Figure 4 is a frame for the rail mill blooming engine that was made to replace the original frame which

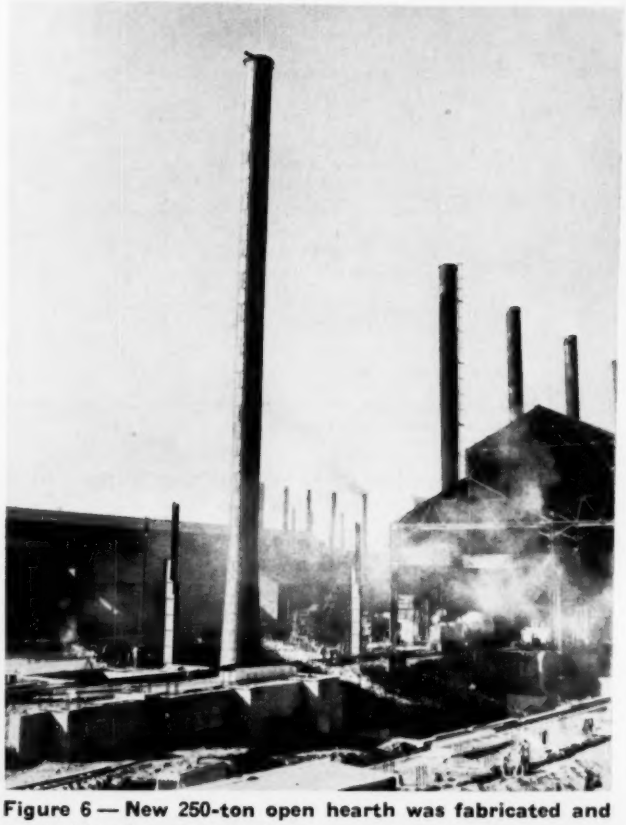


Figure 6 — New 250-ton open hearth was fabricated and erected by shop personnel.

Figure 7 — Shop personnel also fabricated rod mill hot bed.

cracked in several places. This frame, weighing 112 tons, was completed in 90 days, which included all pattern work, casting, annealing, machining and installation. At the time this work was done, delivery of this frame from any outside source would have been approximately 18 months and twice the cost.

Figure 5 shows a portion of the permanent mold we are using to cast 250-cu ft slag pots for open hearth use. This permanent mold, operated by 6000-psi hydraulic oil pressure, was designed, fabricated and put into operation by the mechanical department with a minimum of assistance from other groups in the plant. Although development programs such as this are not too common, it serves as an indicator of the department's service potential. It might be added that the equipment has worked out very satisfactorily and that it is now pos-

Figure 8 — Organization of mason, construction and yard departments.

sible to cast one 15-ton slag pot per day, using only a three-man crew.

Figure 6 shows Pueblo plant's new 250-ton, No. 17 open hearth furnace in the midst of construction. With the exception of a few structural members purchased from outside sources, the entire project including excavation, sheet piling, buildings, furnace and stack, was fabricated and erected by shops personnel.

Pictured in Figure 7 is the new rod mill hot bed just recently put into operation. The entire hot bed was fabricated in the shops during the time that work on No. 17 furnace was in full swing. It can be readily appreciated that accurate scheduling and processing controls are vitally necessary when two jobs of this type are going through shops which originally were built and equipped primarily for maintenance of mill equipment.

Production figures of the foundry can give a further indication of the scope of shop operations. In the year 1957, production amounted to nearly 5,000,000 lb of iron castings, 4,250,000 lb of steel castings, nearly 500,000 lb of brass castings, 5300 ingot molds, weighing over 60,000,000 lb about 4,300,000 lb of slag pots and 6,000,000 lb of ingot mold stools.

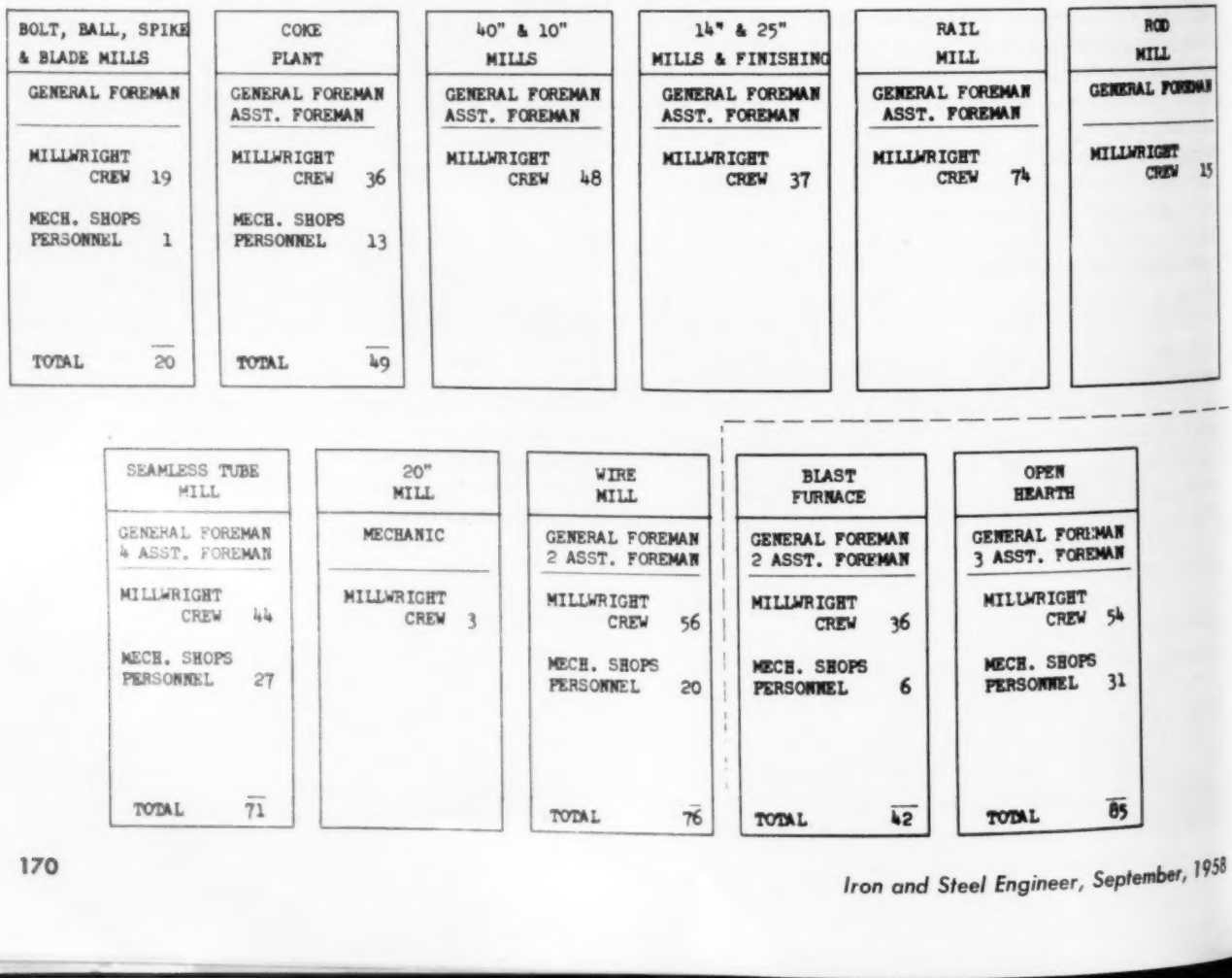
Work which the shops perform for other corporation plants has been steadily increasing over the past several years. Their ability to fabricate items faster and considerably cheaper than outside sources, even taking into account the freight differential involved, has proved very beneficial to corporation operations. Obviously, the offices of the director of mechanical maintenance and the director of engineering have been instrumental in making this program successful, especially where every possible advantage is being taken to duplicate equipment in the various plants.

On a comparative basis, work in the shop units is split between the three basic categories to the approximate extent of 69 per cent operating maintenance, 29 per cent new construction and 2 per cent outside plant work.

Figure 8 shows the organization of the mason, construction, and yard units, each of which draw men from a common pool out of general yard labor. As was also true in the shops, supervisors in these three units have been selected from these units and have proven fully capable of providing the necessary leadership for their crews.

The mason unit works very closely with the bricklayer unit in the open hearth department, supplementing that crew as rebuilds require. Beyond that, they are responsible for all brickwork within the plant, including

Figure 9 — Chart shows men assigned to mechanical maintenance.



such items as blast furnace relines, building erection, stack relining and mill furnace and soaking pit maintenance.

The construction crew is responsible for the excavation and concrete emplacement work within the mill and includes, in addition, all craft painting. It was gratifying to note that during the construction of No. 17 open hearth furnace, this unit excavated some 27,000 cu yd of dirt, poured approximately 9000 cu yd of concrete and drove hundreds of feet of sheet piling without one serious injury. This required especially able supervision in view of the fact that 60 per cent of the men working on the job were new employees, hired from the gate to supplement labor crews during this construction.

A program developed in conjunction with the industrial engineers to modernize the department's 50-ton steam locomotive cranes has been carried out over the past five years. The cranes, after a thorough overhaul, are equipped with 275-hp diesel-torque converter drives operated by air-actuated controls. These conversions have proved highly profitable from an operating and maintenance standpoint and have provided units quite comparable to new equipment.

A number of the responsibilities assumed by the department that again are not strictly mechanical in nature are performed by labor groups employed in the yard department. These would include such items as stock piling, bulk loading and unloading, mill scaling, yard maintenance, road repair, sewer cleaning, etc.

So far this discussion has been leading up to the issue of direct maintenance, which is the final group to be presented. On Figure 9 is shown the organization of the assigned maintenance group throughout the mill. It will be noted that the blast furnace and open hearth departments are set apart from the balance of the plant. Assigned maintenance in these two departments differs from the rest of the plant in that day-to-day supervision is supplied these crews by the operating department. However, as is true in all other groups, supervisors are regularly recruited from the mechanical department for these crews, and all craft and related personnel required are assigned there from the shop and mason units. In addition, and maintenance or construction, other than routine problems, will be referred to the mechanical department, either for assistance or to be performed by them entirely.

Generally speaking, supervision for all assigned mechanical maintenance crews have backgrounds either in the shop units or in the millwright crews themselves. With the exception of the seamless tube mill, a general foreman and one assistant are usually assigned to the various mills. These supervisors normally work day turn only, although their responsibility for mill maintenance is on a 24-hr, 7-day-a-week basis. It has been necessary to assign around-the-clock supervision only at the seamless tube mill where maintenance is confronted with the most mechanically complex mill within the plant.

The performance of the millwright crew at the seamless tube mill is shown in Figure 10 as an indication of the problems confronting assigned maintenance units. At the time the mill was started, not one member of the millwright crew had ever worked at a higher job than a millright helper. In addition, none of these men had

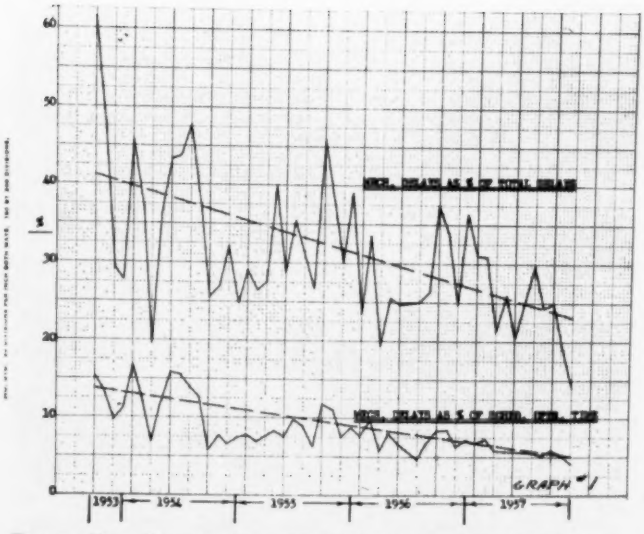


Figure 10 — Curves show reduction in mechanical delays on seamless tube mill from October, 1953 through December, 1957.

even the remotest notion of what a seamless tube mill looked like. To say that there were no mechanical problems during the start up of this mill would be untrue, but, as is shown on the graph, mechanical delays have been reduced in the past four years from 14 per cent to approximately five per cent of scheduled operating time. In addition, mechanical delays which originally accounted for 41 per cent of all delays have since been reduced to a contribution of less than 25 per cent. This has been done with virtually the same number of people assigned to this unit, even though considerable expansion in equipment and in scheduled operating turns have been experienced during that time. Performance of such caliber is the rule rather than exception with all assigned maintenance crews, even though it has been only in recent months that an incentive rate program has been initiated in a number of these units.

On Table I are shown the mechanical delays over a ten-year period and for a recent month for the various rolling mills maintained. A healthy competitive spirit prevails among mechanical, electrical and operating supervisors in keeping delays chargeable to their crews at an absolute minimum. Here again the strident phrase "it ain't mechanical" can be heard during the occasional wrangle over delay-distribution after the stoppage has been cleared. In addition to the basic responsibilities relating to mill production, cost and quality, assigned maintenance supervision are, of course, concerned with spare inventories, preventive maintenance, lubrication, personnel scheduling and coordination of the work of

TABLE I

	Per cent mechanical delays, 10-year average	Per cent operating time, Nov., 1957
Rail mill	3.12	2.33
40-In. mill	3.19	2.16
25-In. mill	1.70	2.79
14-In. mill	1.66	1.63
Rod mill	1.18*	1.49
10-In. mill	1.84	1.39
20-In. mill	0.38	0.15
Seamless mill	9.31**	5.17

* 7-year average.
** 3-year average.

their crews with operating and shop schedules. Here again, the department is extremely fortunate in having especially able supervisors that carry on their work with a minimum of assistance from top department supervision.

It was shown on Figure 9 that a number of shops personnel are employed in various maintenance units. These are primarily machinists, welders, pipe fitters, carpenters and boiler-makers, and are under the direct supervision of the maintenance foremen. Work performed by the craft group may vary from routine maintenance to rebuilding and fabrication and to assisting major construction work in that area.

It is certainly not intended to imply that trained millwright crews are not particularly important to over-all mill operations. Considerable reliance is placed upon the experience, knowledge and industry of this group for the day-to-day upkeep and repair of equipment. These men have all "come up the ladder the hard way," as it is a general policy to hire men into these units as helpers and promote them to higher classifications only after they have demonstrated their ability to perform such assignments. No formal training program exists for these men, placing an even heavier responsibility on their supervision for this training.

A large portion of maintenance work encountered is performed in mills that have been operating for over 60 years. In those areas, the equipment has, of necessity, become rugged and relatively straight-forward from a mechanical standpoint. Preventive maintenance procedures have been developed out of long experience so that unscheduled downtime is due primarily to abnormal abuse of equipment, human error or inadequate equipment that has not yet been replaced to suit current operating conditions. In newer mills, preventive maintenance is playing a very important part in the successful operation of these units. Although from an operating standpoint, automation has proved very beneficial, maintenance requirements on such equipment are enormously more complex. Failure of a single component such as a gasket or valve seat in this equipment can shut an entire mill down just as effectively as the loss of a main drive unit and trouble-shooting these breakdowns is usually infinitely more difficult. For that reason, it is necessary to train all assigned maintenance personnel constantly in the complete scope of work encountered in their mills. The need for constant inspection and reporting of potential difficulties is stressed not only by maintenance personnel, but by operating crews as well. Planned replacement or repair schedules have been developed for many pieces of equipment which, experience indicates, have reached the critical point in life expectancy. A program of this nature must be continually expanding and its success rests chiefly upon the shoulders of maintenance and operating supervision. To carry this aim even further, maintenance foremen are often able to develop new equipment or redesign existing machines to eliminate many problems previously encountered. In line with this, the experience and knowledge of these foremen are invaluable in passing judgment on mechanical changes made within their assigned areas. Considerable emphasis is placed on the selection of interchangeable equipment wherever this is practicable, thereby reducing the over-all complexities of equipment and in addition, greatly simplifying the maintenance of spare parts. Obviously the cost factor is benefited by such selection.

In conclusion, it should again be emphasized that successful maintenance must have as its objective the reduction of operating costs through reduced breakdowns, increased productivity and improved product quality. This goal can never be attained without well trained personnel led by outstanding men in supervisory ranks, who are genuinely interested in all phases of mill operation. The mechanical department has accepted this goal as its basic responsibility and, with the personnel and supervisors available, there is little doubt that it can be reached. ▲

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1010 Empire Building **Pittsburgh 22, Pa.**

Recent Innovations in Blast Furnace Maintenance and Rebuilding

by Louis Torok
Planning Engineer
Bethlehem Steel Co., Bethlehem, Pa.

Blast furnace operators and maintenance men are constantly finding new "kinks" which help and speed operation and repair of these important units.

IMPROVEMENTS in methods of repairing or rebuilding blast furnaces may be attributable to various reasons. The practice may have been changed for safety reasons; it may be dictated by the acquisition of some new equipment; or it may be adopted because it offers economies in cost.

In the never ending struggle for increased efficiency,

Figure 1 — Installation of a plate bulkhead against the inside lip of the off-take casting speeds up repairs.

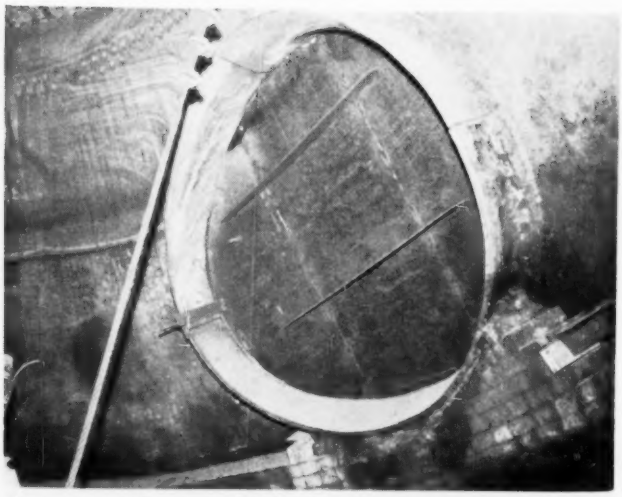

Figure 2 — The completed plate bulkhead against which brick repairs are started is made in halves or thirds, of $^{3}/_{16}$-in. plate.

Figure 3 — Guniting operation has started in this portion of blast furnace stack.

Figure 4 — The gunited refractory material acts as a protection for the cooling plates.

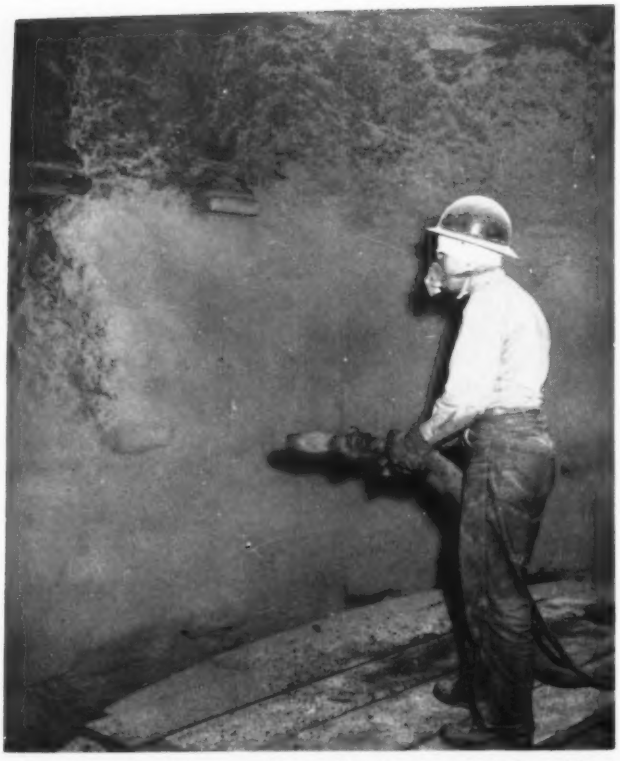

Figure 5 — Applying gunited refractory material to blast furnace lining was done on day shift only to allow material to set up overnight.

Figure 7 — Portion of tuyere and bosh jacket must be removed to take out stack and lining.

Figure 6 — Completed portion of eroded section of stack lining appears as shown.

Figure 8 — Mechanical equipment removes and loads stock from a blast furnace.

it is necessary that some improvements be made each time a furnace is rebuilt or repaired. Some of these changes may be of little significance and may only apply to local conditions, while others may have much greater impact and may be adapted for use thoughout the industry.

This paper will deal with three items used during 1957 in the Bethlehem plant of the Bethlehem Steel Co.

1. Steel bulkheads in off-takes from the dome.

The purpose of the steel bulkhead is twofold. First, it is a safety precaution to prevent debris from falling on the men working on the hanging scaffold. Second, it speeds up brick repairs in the off-takes. A plate bulkhead $^{3}/_{16}$ in. thick is designed and prefabricated to fit the inside lip of the off-take casting. One ring of brick is removed so that the plate can be installed. The plate is made in halves or thirds, depending on the diameter of the off-take casting, and must be fitted tightly against the lip of the off-take casting.

With this tight installation of the plate against the off-take casting, the bricklayers are able to start their repairs by laying the brick against the plate.

The bulkheads are easily removed upon completion of repairs to the furnace. After the scaffold inside the furnace is raised to its last working level, the plate bulkhead is removed by burning it out.

The plate bulkhead has served its purpose as a safety device and as a means of speeding up brick repairs.

2. Guniting eroded portion of a blast furnace lining.

Figure 9 — Crawler unit with 12-ft extension has a reach of 38 ft.

Figure 10 — Bucket had linkage changed to increase efficiency of unit.

The lining of the "C" blast furnace at the Bethlehem plant was checked during a stock-line repair. An eroded area was found in the stack lining between the 17th and 21st rows of stack-cooling plates. The average extension of the cooling plates beyond the lining was 12 in., and the vertical distance of the eroded area was 15 ft.

The decision was made to gunite this area with a refractory to prevent the eroded area from extending vertically and towards the furnace shell. The refractory material would also act as a protection for the cooling plates.

Two gunite units were set up outside the furnace and the job was started. A sound system with microphones was used for communication between the preparation area and the working area inside the furnace.

A good base was developed at the 17th row of cooling plates to serve as the main support for the refractory material as it was applied to the eroded vertical section of stack lining.

The guniting was done during the day shift only so that the gunite set up overnight. This was necessary because the vertical distance was too great for it to be done in a continuous operation without any setup time. Three working shifts were required to complete the guniting of the eroded area.

A total of 2025 bags of refractory material was used for guniting the eroded area of the blast furnace lining or 202,500 lb of refractory material.

3. Removal of stock or lining from a blast furnace.

Upon completion of the water quench and after having taken all the necessary safety measures, the operating department turns the furnace over to the service division. To take out the stock and lining, a section of tuyere jacket and bosh must first be removed. The location of these sections is determined during the preparatory planning stage.

After the plate section of tuyere and bosh is removed, a hole is dynamited through the lining. All exposed brick area is then removed. A crawler unit with a telescopic boom is moved into position and the stock is scooped from the furnace, after which a front-end loader removes the material from the area.

The material is loaded on trucks and sent to the salvage site for reclamation. The stock is removed as quickly as possible to eliminate any clinkering action.

With the use of this type of crawler unit, the operation of removing stock has been greatly simplified. The unit is able to remove hot material with ease. Hot stock is encountered in the stockline repair jobs where the quenching of the stock is kept to a minimum to prevent damage to the stack lining and carbon hearth.

The efficiency of the crawler unit can be increased, when more reach is required, by installing a 12-ft boom extension. This will increase the maximum reach to 38 ft. To further increase the efficiency of the unit, the linkage on the bucket has been changed to permit operation from a horizontal position.

The use of this crawler unit in stock and lining removal has resulted in a safer and faster operation and the work is completed with far less confusion.

Discussion

PRESENTED BY

C. F. McCLURG, Assistant Division Superintendent, Maintenance and Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

LOUIS TOROK, Planning Engineer, Bethlehem Steel Co., Bethlehem, Pa.

C. F. McClurg: One thing that interested me was the addition that you put onto your grade-all. How did the turning movement of the bucket operate with the change in linkage? From our experience the power requirements for the standard unit is about correct with standard linkage. Did you have sufficient power for turning with the changed linkage?

Louis Torok: By putting on the bucket with the linkage change, which I showed on Figure 10, the efficiency of the bucket was not changed as far as the turning movement of the bucket was concerned. We found it to be just as effective as with the other bucket, with which you are familiar.

The changed linkage did not decrease the turning power of the boom. The bucket was used on furnaces with a larger hearth diameter to get out the material and not damage the furnace lining. ▲

PROGRAM

1958 AISE CONVENTION and IRON AND STEEL EXPOSITION

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CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO

TUESDAY, SEPTEMBER 23

9:00 am—REGISTRATION—Main Lobby

9:15 am—BUSINESS MEETING—Ballroom

Conducted by President Leonard Larson

9:30 am—ELECTRICAL SESSION—Ballroom

Chairmen: J. A. Drgon, Division Superintendent, Maintenance and Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.
B. R. King, Assistant Superintendent, Electrical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Industrial Telemetering Systems," by Charles D. Close, President, cdc Control Services, Inc., Hatboro, Pa.

"Power Dispatching in a Steel Mill," by C. L. Eichenberg, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

"Design Concepts and Electric Drive Systems for Reversing Hot Mills," by R. W. Kirkland, R. E. Marrs, Systems Application Engineers, Engineering Section, and W. E. Miller, Manager, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

9:30 am—SINTERING SESSION—Club Room B

Chairman: W. O. Bishop, Superintendent, Plant 2, Blast Furnaces, Inland Steel Co., East Chicago, Ind.

"New Screening and Sinter Plant Facilities—Inland Steel Co.," by William O. Bishop, Superintendent, Plant No. 2 Blast Furnaces, and C. P. Frame, Assistant Superintendent, Sintering Plants, Inland Steel Co., East Chicago, Ind.

"Layout and Design of The Ashland Sintering Plant," by Richard W. Adams, Area Engineer—Blast Furnaces and Foundry, Ashland Works, Armco Steel Corp., Ashland, Ky.

"Weirton No. 2 Sinter Plant," by G. W. Watson, Superintendent Sinter Plants, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"J&L's Cleveland Works Sinter Plant," by K. S. Loofboro, Superintendent Blast Furnaces, Coke Ovens and Docks, Jones & Laughlin Steel Corp., Cleveland, Ohio.

2:00 pm—COMBUSTION SESSION—Club Room B

Chairmen: W. M. Bloom, Fuel Engineer, Allegheny Ludlum Steel Corp. Brackenridge, Pa.
E. W. Fitch, Chief Combustion Engineer, Republic Steel Corp., Youngstown, Ohio.

"Monolithic Refractory Constructions in Steel Plant Equipment—Plastic and Castable Refractories Compared," by George D. Cobaugh, Manager Specialty Sales, and Charles D. Hauth, Technical Sales, Harbison-Walker Refractories Co., Pittsburgh, Pa.

"Controlling Oxygen and Moisture to a Blast Furnace," by J. L. Wallace, Foreman, Steel Works, Fuel Dept., Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"Opened Coil Annealing—A Steelman's Dream Come True," by Lee Wilson, Chariman of the Board, Lee Wilson Engineering Co., Inc., Cleveland, Ohio.

2:00 pm—MANAGEMENT SESSION—Ballroom

Chairmen: L. A. Fugassi, Assistant Chief Engineer, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.
H. L. Jenter, Vice President—Operations, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio.

"Incentive Trends in the Steel Industry," by John C. Cramer, Vice President, Albert Ramond & Associates, Inc., Chicago, Ill.

"Controlling Maintenance Costs," by Harold B. Maynard, President, H. B. Maynard and Co., Inc., Pittsburgh, Pa.

"Increased Costs of Production in Steel: The Problem and Possible Solution," by William T. Hogan, S. J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

WEDNESDAY, SEPTEMBER 24

9:00 am—ELECTRICAL SESSION—Ballroom

Chairmen: J. F. Kostelac, Assistant Electrical Superintendent, Crucible Steel Co. of America, Midland, Pa.
Richard G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

"Increased Production Through Electrolytic Tinning Line Modernization," by Donald H. Jenter, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio.

"A Modern High Speed Tandem Cold Reduction Tinplate Mill," by Nelson W. Hocking, Jr., Chief Plant Engineer, Wheeling Steel Corp., Yorkville, Ohio, and A. F. Kenyon, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Modernizing Granite City's Tandem Cold Mill—From a 1946 Model to a 1958 Model in Three Weeks," by A. W. Schlechte, Chief Electrical Engineer, R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill., R. M. Peeples, Supervisory Engineer, Control Dept., and D. E. Rea, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: T. J. Harrison, Superintendent of Combustion, Continental Steel Corp., Kokomo, Ind.
R. A. Lambert, Superintendent Steam Efficiency and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Utilization of By-Product Fuels," by R. W. Worley, Chief Power Engineer, and R. H. Gherst, Senior Power Engineer, United Engineers & Constructors Inc., Philadelphia, Pa.

Exposition and Technical Sessions are at Cleveland Public Auditorium . . . So

"**Atomization of Open Hearth Fuel Oil with High Pressure Gas,**" by J. D. Wells, Open Hearth Engineer, and Guy L. Rogers, Works Engineer, Sheffield Div., Armco Steel Corp., Houston, Texas.

"**The Twin Pillars of Profit—Blast Furnaces and Power,**" by Austin E. McDonough, Division Superintendent, Blast Furnaces, and George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

2:00 pm—MECHANICAL SESSION—Ballroom

Chairmen: R. A. Kraus, Superintendent, Mechanical Maintenance, Republic Steel Corp., Chicago, Ill.
S. W. Stouffer, Assistant Director of Construction and Maintenance, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

"**Cyclic Welding Method Salvages Heavy Mill Equipment,**" by R. L. Rectenwald, President, Maintenance Engineering Corp., Pittsburgh, Pa.

"**Organizing a Steel Plant Preventive Maintenance Program,**" by Richard F. Armitage, General Superintendent, Warren District, Republic Steel Corp., Warren, Ohio.

"**Cost Estimating—Metal Working Plants,**" by A. J. Mosso, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: N. A. Bracht, Lubrication Engineer, Alan Wood Steel Co., Conshohocken, Pa.
Robert L. Humphreys, Lubrication Engineer, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

"**Recent Activity Concerning Antifriction Roll Neck Bearing Designs and Mountings,**" by E. C. Denne, Jr., Manager, Rolling Mill Dept., SKF Industries, Inc., Philadelphia, Pa.

"**Maintenance of Mill Oil Bearings,**" by C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. Cooper, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio.

"**An Approach to Wire Rope Lubrication,**" by Louis A. Stanzione, Engineer, Williamsport Plant, Bethlehem Steel Co., Williamsport, Pa.

6:00 pm—OLD TIMERS DINNER

THURSDAY, SEPTEMBER 25

9:00 am—ROLLING MILL SESSION—Ballroom

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.
R. P. Schuler, Manager, North Mills, Inland Steel Co., East Chicago, Ind.

"**Recent Developments in Pipe and Tube Mill Machinery,**" by Dieter Hancke, Vice President—Sales, and Robert Hartenstein, Vice President—Engineering, Mannesmann-Meer Inc., Youngstown, Ohio.

"**Lone Star Steel's New Stretch-Reducing Mill,**" by Leonard Eller, Superintendent, E. W. Pipe Mills, Lone Star Steel Co., Dallas, Texas.

"**Recent Developments in Design and Control of Hot Strip Mills,**" by Richard W. Barnitz, Chief Electrical Engineer, and H. H. Shakely, Plants Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

9:00 am—LUBRICATION SESSION—Club Room B

Chairmen: A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.
E. J. Hochdanner, Works Engineer, Brackenridge Plant, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"**Considerations for the Application of Fire Resistant Fluids,**" by C. T. Lewis, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.

"**Standardization of Lubricants for Steel Mills,**" by P. D. Metzger, Associate Research Engineer, Lubrications Testing Laboratory, and H. D. Foster, Standards Engineer, Wheeling Steel Corp., Wheeling, W. Va.

"**Micro Chemistry in Lubricating Oil Analysis,**" by F. M. Roberts, Supervisor, Analytical Dept., Texaco Research Center, The Texas Co., Beacon, N. Y.

2:00 pm—OPERATING PRACTICE SESSION—Ballroom

Chairmen: George I. Bottcher, Chief Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Warren E. Hart, Superintendent, Electric Furnace Building, Ford Motor Co., Rouge Plant, Dearborn, Mich.

"**Perfected and Practical Methods of Processing Powder into Commercial Strip,**" by Richard A. Smucker, Application Engineer, E. W. Bliss Co., Salem, Ohio.

"**Development of a New Horizontal Flow, Plate Type Precipitator for Blast Furnace Gas Cleaning,**" by Bengt R. Berg, Manager, Precipitator Division, AB Svenska Flaktfabriken, Stockholm, Sweden.

"**The Strategic-Udy Direct Iron Reduction Process,**" by Dr. Marvin J. Udy, Vice President, Strategic-Udy Processes, Inc., Niagara Falls, N. Y., and Robert A. Blackburn, Sales Engineer, Koppers Co., Inc., Pittsburgh, Pa.

2:00 pm—FOREIGN SESSION—Club Room B

Chairmen: R. W. Holman, Division Chief Engineer, Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala.
Emil Kern, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"**Present Situation of Japanese Steel Industry,**" by Kichiro Saigo, Manager, New York Office, Yawata Iron & Steel Co., Ltd., New York, N. Y.

"**The Venezuelan Steel Works,**" by M. Gonni, Manager Engineering and Construction Div., Innocenti S.G., Milano, Italy.

"**Compania de Acero del Pacifico—Chile, Its Inception and Growth,**" by Juan Zapata, Vice President, Representative in USA, Compania de Acero del Pacifico, New York, N. Y.

7:00 pm—FORMAL DINNER Ballrooms

Speaker: Miss Emily Kimbrough

10:00 pm—DANCE—Ballrooms

AISE members and guests. No admission charge.

FRIDAY SEPTEMBER 26

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: David Cousley, Assistant Superintendent, Utilities, Wheeling Steel Corp., Steubenville, Ohio.
C. W. Dunn, Superintendent Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"**Modern Regenerative Soaking Pits,**" by Henry S. Hall, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

"**Special Features of Stelco's New Soaking Pits,**" by E. T. W. Bailey, Chief Combustion Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

"**Heating Facilities for Youngstown Sheet and Tube's New Seamless Mill,**" by F. C. McGough, Superintendent of Fuel and Power, Youngstown Sheet and Tube Co., Indiana Harbor, Ind.

. . . Social Functions are at Hotel Statler

2:00 pm—OPERATING PRACTICE SESSION—Club Room B

Chairmen: W. H. Collison, Plant Superintendent, Blast Furnaces and Coke Plant, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Mich.
Charles H. Good, Jr., Chief Engineer, Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Electric Arc Furnace Analysis via Photography," by J. A. Brosovic, Senior Project Engineer, Electrical Laboratory, Republic Steel Corp., Cleveland, Ohio.

"Vacuum Pouring for Large Forging Production," by Elliott A. Reid, Assistant Chief Metallurgist, Bethlehem Steel Co, Bethlehem, Pa.

"Nuclear Energy Applications to Steel Plant Operations," by Patrick J. Selak, Manager, Nuclear Engineering Development, and Rudolph Tietig, Jr., Principal Engineer, Steel Plants Div., Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.

2:00 pm—ELECTRICAL SESSION—Ballroom

Chairmen: James R. Lamberton, Electrical Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.
Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"E. O. T. Crane Runway Rail Installations," by W. J. Tunny, Superintendent, Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

"Design and Performance of Industrial Lighting Systems," by Daniel J. O'Neill, Manager of Industrial Lighting, Holophane Co., Inc., New York, N. Y.

"Protecting Your Cable Investments," by Charles Van Hoy, Rubber Power Cable Engineer, Anaconda Wire & Cable Co., Marion, Ind.

IRON AND STEEL EXPOSITION HOURS

SEPTEMBER 23—TUESDAY . . . . . 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 24—WEDNESDAY . . . . . 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 25—THURSDAY . . . . . 10:00 A.M. TO 5:00 P.M.
SEPTEMBER 26—FRIDAY . . . . . 10:00 A.M. TO 4:00 P.M.

IRON AND STEEL EXPOSITION

Exhibit Hall.....**Booth Nos. 1-199**
North Hall.....**Booth Nos. 200-299**
Arcade.....**Booth Nos. 300-399**
Upper Lakeside Hall.....**Booth Nos. 400-599**

LIST OF EXHIBITORS

A

Adalet Manufacturing Co., The
Ajax Flexible Coupling Co., Inc.
Allen-Bradley Co.
Alliance Machine Co., The
Allis Co., The Louis
Allis-Chalmers Manufacturing Co.
American Air Filter Co., Inc.
American Brake Shoe Co.
American Steel & Wire Div., U. S. Steel Corp.
Anaconda Wire & Cable Co.
Appleton Electric Co.
Ashland Oil & Refining Co., Inc.
Askania Regulator Co.
Atwater Engineering, Inc., K. W.
Automatic Transportation Co.

B

Bailey Meter Co.
Bearing Service Co.
Blaw-Knox Co.
Bliss Co., E. W.
Bloom Engineering Co., Inc.
Buell Engineering Co.

C

Chalfant Products Co.
Chandeysson Electric Co.
Chemical Construction Corp.
Chromium Corp. of America
Cities Service Petroleum, Inc.
Clark Controller Co., The
Cleveland Crane & Engineering Co.
Cleveland Engineering Society

LIST OF EXHIBITORS (Continued)

Cleveland Safety Council
Cleveland Worm & Gear Co.
Cooper Split Roller Bearing Corp.
Crouse-Hinds Co.
Cunningham Co., M. E.
Curry Air Shear Corp.
Cutler-Hammer, Inc.

D

Detrick Co., M. H.
Dowell, Div. of Dow Chemical Corp.
Dravo Corp.

E

Edison Industries Div. of McGraw-Edison Co., Thos. A.
Electric Furnace Co., The
Electric Storage Battery Co., Exide Industrial Div.
Elliott Co.
Elwell-Parker Electric Co., The
Enterprise Co., The
Erico Products, Inc.
Euclid Electric & Mfg. Co., The

F

Fabreeka Products Co.
Farval Corp.
Federal-Mogul-Bower Bearings, Inc.
Femco, Inc.
Fenn College
Foote Bros. Gear and Machine Corp.
Foxboro Co., The

G

GPE Controls, Inc.
Gear Grinding Machine Co., The
General Electric Co.
Gleason Reel Corp.
Golden-Anderson Valve Specialty Co.
Gould-National Batteries, Inc., Industrial Div.
Gould-National Batteries, Inc., Nicad Div.,
Gulf Oil Corp.
Guyan Machinery Co.

H

Hagan Chemicals & Controls, Inc.
R. L. Hanson Co.
Harnischfeger Corp.
Heil Process Equipment Corp.
Heyl & Patterson, Inc.
Hodson Corp., The
Holophane Co., Inc.
Homestead Valve Manufacturing Co.
Houghton & Co., E. F.
Hunt & Son, Inc., C. B.
Hyatt Bearings Div., General Motors Corp.
Hyde Park Foundry & Machine Co.

I

Industrial Gauges Corp.
"Industrial Heating"
Industrial Nucleonics Corp.
"Iron Age, The" - Chilton Co.
Iron Lung Ventilator Co.
I-T-E Circuit Breaker Co.

J

Jackson Industries, Inc.
Joy Manufacturing Co., Electrical Products Div.

K

Kinney Engineers, Inc., S. P.
Kolene Corp.
Koppers Co., Inc., Metal Products Div.

L

Larco, Inc.
Leeds & Northrup Co.
Link-Belt Co.
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp.

M

Magnaflux Corp.
Mansaver Industries, Inc.
Martindale Electric Co., The
McDowell Co., Inc.
McGill Manufacturing Co., Inc.
Messer Cutting Machines, Inc.
Mesta Machine Co.
"Metal Progress" American Society For Metals
Mine Safety Appliances Co.
Minneapolis-Honeywell
Morgan Construction Co.
Morgan Engineering Co., The
Motor Coils Mfg. Co.

N

National Electric Coil Co.
National Safety Council
Nife Incorporated
North American Manufacturing Co., The

O

Ohio Bell Telephone Co., The
Ohio Carbon Co., The
Ohio Electric Mfg. Co., The

P

Pangborn Corp.
Pannier Corp., The
Pittsburgh Corning Corp.
Poole Foundry & Machine Co.
Porter Co., Inc., H. K., Delta-Star Electric Div.
Post-Glover Electric Co., The
Pringle Electrical Mfg. Co.
Pyle-National Co., The

R

Radiant Lamp Corp.
Ramtite Co., The
Ready-Power Co., The
Red Seal Electric Co.
Reintjes Co., Geo. P.
Reliance Electric and Engineering Co.
Republic Flow Meters Co.
Richardson-Allen Corp.
Ringsdorff Carbon Corp.
Robinson Ventilating Co.
Rockbestos Products Corp.
Rollway Bearing Co., Inc.
Rust-Oleum Corp.

S

Selas Corp. of America
Shell Oil Co.
Simonds Abrasive Co.
Simplex Wire & Cable Co.
SKF Industries, Inc.
Socony Mobil Oil Co., Inc.
Solvent Service, Inc.
Spraying Systems Co.
Square D Co.
"Steel" - Penton Publishing Co.
Sutton Engineering Co.
Swindell-Dressler Corp.

T

Taylor Instrument Companies
Telechrome Manufacturing Corp.
Texas Co., The
Timken Roller Bearing Co., The
Tool Steel Gear & Pinion Co.
Torrington Co., The, Bantam Bearings Div.
Trabon Engineering Corp.
Treadwell Construction Co.

U

Union Carbide Corp.
United States Department of Commerce

W

Wagner Electric Corp.
Waldron Corp., John
Wargo Co., William E.
Western Precipitation Corp.
Westinghouse Electric Corp.
Wheelabrator Corp.
Wilson Engineering Co., Inc., Lee
Wing Mfg. Co., L. J., Div. of Aero Supply Mfg. Co., Inc.

Y

Yale & Towne Manufacturing Co., The

Z

Zurn Industries, Inc.

2:00 pm—OPERATING PRACTICE SESSION—Club Room B

Chairmen: W. H. Collison, Plant Superintendent, Blast Furnaces and Coke Plant, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Mich.
Charles H. Good, Jr., Chief Engineer, Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

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"Vacuum Pouring for Large Forging Production," by Elliott A. Reid, Assistant Chief Metallurgist, Bethlehem Steel Co., Bethlehem, Pa.

"Nuclear Energy Applications to Steel Plant Operations," by Patrick J. Selak, Manager, Nuclear Engineering Development, and Rudolph Tietig, Jr., Principal Engineer, Steel Plants Div., Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.

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Chairmen: James R. Lamberton, Electrical Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.
Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"E. O. T. Crane Runway Rail Installations," by W. J. Tunny, Superintendent, Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

"Design and Performance of Industrial Lighting Systems," by Daniel J. O'Neill, Manager of Industrial Lighting, Holophane Co., Inc., New York, N. Y.

"Protecting Your Cable Investments," by Charles Van Hoy, Rubber Power Cable Engineer, Anaconda Wire & Cable Co., Marion, Ind.

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Anaconda Wire & Cable Co.
Appleton Electric Co.
Ashland Oil & Refining Co., Inc.
Askania Regulator Co.
Atwater Engineering, Inc., K. W.
Automatic Transportation Co.

B

Bailey Meter Co.
Bearing Service Co.
Blaw-Knox Co.
Bliss Co., E. W.
Bloom Engineering Co., Inc.
Buell Engineering Co.

C

Chalfant Products Co.
Chandeysson Electric Co.
Chemical Construction Corp.
Chromium Corp. of America
Cities Service Petroleum, Inc.
Clark Controller Co., The
Cleveland Crane & Engineering Co.
Cleveland Engineering Society

LIST OF EXHIBITORS (Continued)

Cleveland Safety Council
Cleveland Worm & Gear Co.
Cooper Split Roller Bearing Corp.
Crouse-Hinds Co.
Cunningham Co., M. E.
Curry Air Shear Corp.
Cutler-Hammer, Inc.

D

Detrick Co., M. H.
Dowell, Div. of Dow Chemical Corp.
Dravo Corp.

E

Edison Industries Div. of McGraw-Edison Co., Thos. A.
Electric Furnace Co., The
Electric Storage Battery Co., Exide Industrial Div.
Elliott Co.
Elwell-Parker Electric Co., The
Enterprise Co., The
Erico Products, Inc.
Euclid Electric & Mfg. Co., The

F

Fabreeka Products Co.
Farval Corp.
Federal-Mogul-Bower Bearings, Inc.
Femco, Inc.
Fenn College
Foote Bros. Gear and Machine Corp.
Foxboro Co., The

G

GPE Controls, Inc.
Gear Grinding Machine Co., The
General Electric Co.
Gleason Reel Corp.
Golden-Anderson Valve Specialty Co.
Gould-National Batteries, Inc., Industrial Div.
Gould-National Batteries, Inc., Nicad Div.,
Gulf Oil Corp.
Guyan Machinery Co.

H

Hagan Chemicals & Controls, Inc.
R. L. Hanson Co.
Harnischfeger Corp.
Heil Process Equipment Corp.
Heyl & Patterson, Inc.
Hodson Corp., The
Holophane Co., Inc.
Homestead Valve Manufacturing Co.
Houghton & Co., E. F.
Hunt & Son, Inc., C. B.
Hyatt Bearings Div., General Motors Corp.
Hyde Park Foundry & Machine Co.

I

Industrial Gauges Corp.
"Industrial Heating"
Industrial Nucleonics Corp.
"Iron Age, The" - Chilton Co.
Iron Lung Ventilator Co.
I-T-E Circuit Breaker Co.

J

Jackson Industries, Inc.
Joy Manufacturing Co., Electrical Products Div.

K

Kinney Engineers, Inc., S. P.
Kolene Corp.
Koppers Co., Inc., Metal Products Div.

L

Larco, Inc.
Leeds & Northrup Co.
Link-Belt Co.
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp.

M

Magnaflux Corp.
Mansaver Industries, Inc.
Martindale Electric Co., The
McDowell Co., Inc.
McGill Manufacturing Co., Inc.
Messer Cutting Machines, Inc.
Mesta Machine Co.
"Metal Progress" American Society For Metals
Mine Safety Appliances Co.
Minneapolis-Honeywell
Morgan Construction Co.
Morgan Engineering Co., The
Motor Coils Mfg. Co.

N

National Electric Coil Co.
National Safety Council
Nife Incorporated
North American Manufacturing Co., The

O

Ohio Bell Telephone Co., The
Ohio Carbon Co., The
Ohio Electric Mfg. Co., The

P

Pangborn Corp.
Pannier Corp., The
Pittsburgh Corning Corp.
Poole Foundry & Machine Co.
Porter Co., Inc., H. K., Delta-Star Electric Div.
Post-Glover Electric Co., The
Pringle Electrical Mfg. Co.
Pyle-National Co., The

R

Radiant Lamp Corp.
Ramtite Co., The
Ready-Power Co., The
Red Seal Electric Co.
Reintjes Co., Geo. P.
Reliance Electric and Engineering Co.
Republic Flow Meters Co.
Richardson-Allen Corp.
Ringsdorff Carbon Corp.
Robinson Ventilating Co.
Rockbestos Products Corp.
Rollway Bearing Co., Inc.
Rust-Oleum Corp.

S

Selas Corp. of America
Shell Oil Co.
Simonds Abrasive Co.
Simplex Wire & Cable Co.
SKF Industries, Inc.
Socony Mobil Oil Co., Inc.
Solvent Service, Inc.
Spraying Systems Co.
Square D Co.
"Steel" - Penton Publishing Co.
Sutton Engineering Co.
Swindell-Dressler Corp.

T

Taylor Instrument Companies
Telechrome Manufacturing Corp.
Texas Co., The
Timken Roller Bearing Co., The
Tool Steel Gear & Pinion Co.
Torrington Co., The, Bantam Bearings Div.
Trabon Engineering Corp.
Treadwell Construction Co.

U

Union Carbide Corp.
United States Department of Commerce

W

Wagner Electric Corp.
Waldron Corp., John
Wargo Co., William E.
Western Precipitation Corp.
Westinghouse Electric Corp.
Wheelabrator Corp.
Wilson Engineering Co., Inc., Lee
Wing Mfg. Co., L. J., Div. of Aero Supply Mfg. Co., Inc.

Y

Yale & Towne Manufacturing Co., The

Z

Zurn Industries, Inc.

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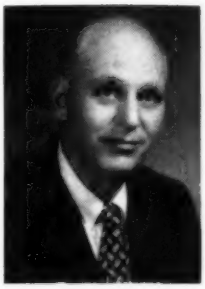
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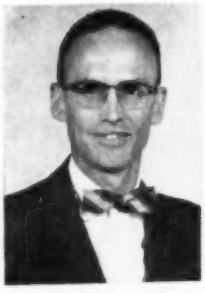
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ABSTRACTS OF TECHNICAL PAPERS

to be presented at technical sessions of

AISE ANNUAL CONVENTION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

September 23, 24, 25, 26

1958

"INDUSTRIAL TELEMETERING SYSTEMS"

by CHARLES D. CLOSE, President, cdc Control Services, Inc., Hatboro, Pa.

C. D. CLOSE

Δ WITH the need to bring the entire mill under central control for maximum economic utilization, telemetering or remote transmission of metered information becomes a must.

Since the steelmaking process has power demands that include both sudden and sustained types, by the proper use of telemetry and central control, the use of various power elements, fuel (oil gas and coal), electricity, steam, etc., can average demand requirements which increase facility utilization and reduce standby demand costs.

Telemetering systems are discussed from a standpoint of cost, expected reliability, flexibility, expansion capabilities, emergency operation, data utilization, and accuracy of transmission. Principal types of telemetering discussed include d-c continuous signal, a-c continuous signal, time pulse duration, amplitude modulation, frequency shift and digital transmission.

Strengths and weaknesses of information transmission are discussed as related to the above-described systems.

Central control center design for adequate central control includes the human engineering aspects of record keeping, supervisory review, urgent decision making, information up to date, flexibility of presentation, etc.

Ultimate telemetering systems for central control are described allowing maximum reliable control from a central control center.

"POWER DISPATCHING IN A STEEL MILL"

by C. L. EICHENBERG, Assistant Superintendent Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

C. L. EICHENBERG

Δ THE use of electric power in steel manufacture is approaching its seventy-fifth anniversary, and virtually complete electrification of the industry was completed thirty-five years ago. Despite this fact, the kwhr per ton of steel production has been steadily increasing. This increase means that electric power is more important than ever, and an adequate and constant supply to meet the demands of production is a must.

The problems of providing power as needed without a break in continuity falls into the category of power dispatching. The need for dispatching varies between companies, but completely integrated plants utilizing local generation plus purchased power have a great deal to gain by installing a system of dispatching.

The Bethlehem plant of the Bethlehem Steel Co. has been utilizing a power dispatcher for over 15 years. The results of this system of operation have been very gratifying from the standpoint of reducing delays in production and minimizing interruptions.

The power dispatcher has a number of well-defined responsibilities. All system operations are under his

control and he is in complete charge of all equipment and line outages which require a permit for protection of personnel.

The permit system of blocking out power apparatus is recognized as one of the most effectual means of safeguarding the lives of people who are associated with the maintenance of high voltage equipment. This system provides the greatest number of safeguards without sacrificing continuity of operation.

The load dispatcher has many aids to assist in maintaining continuous service, not the least of which is effective relaying schemes. These schemes perform functions such as segregation of the system when the loss of purchased power capacity does not permit carrying full plant load, the prompt removal of faulted lines and equipment, and the automatic reclosure under controlled conditions of faulted lines.

Supervisory controls also provide a great assist to the dispatcher and permit prompt restoration of service in unattended stations. The combination of qualified personnel and effectual relaying make it possible to operate a power system with a maximum of reliability and a minimum service loss.

"DESIGN CONCEPTS AND ELECTRIC DRIVE SYSTEMS FOR REVERSING HOT MILLS"

by R. W. KIRKLAND and R. E. MARRS, Systems Application Engineers, Engineering Section, and W. E. MILLER, Manager, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. W. KIRKLAND

△ AS rolling mills become more completely automated, productive capacity becomes more completely keyed to electric drive systems performance. The reversing hot mill traditionally has had a low utilization factor. Metal has usually been in the main drive rolls only 25 to 50 per cent of the time. The remaining time has been spent in manipulating, conveying the piece to and from the mill, reversing the mill and operating the screwdowns and other auxiliaries.

Automation is expected to improve the efficiency of the operation and to improve product quality. The load peaks will remain the same but there will be many more of them per turn.

R. E. MARRS

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Increased production and reliability can only be achieved by change and it is quite natural that this change should be in the electric drive system, for what is more flexible?

In this paper, system and component designs have been completely reviewed for automation and technological improvement. Motors, motor-generator sets and control designs for an era of production, product quality and profit pressures are presented.

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Today's reversing blooming and slabbing mills have enormous production capabilities, and an ever increasing capital expenditure is required for each new facility. Economic pressures will accelerate the evolution from mechanization to automation. Long range planning becomes even more important. Process and drive systems need to be reviewed in terms of our expanding technology to be sure that today's expansion and modernization programs represent desirable and wise contributions to tomorrow's operations.

"NEW SCREENING AND SINTER PLANT FACILITIES—INLAND STEEL CO."

by WILLIAM O. BISHOP, Superintendent, Plant No. 2 Blast Furnaces, and C. P. FRAME, Assistant Superintendent, Sintering Plants, Inland Steel Co., East Chicago, Ind.

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The circular cooler is possibly the largest of its type with a mean diameter of 80 ft and a capacity of 8400 net tons per day. The sinter is fine screened prior to cooling and again later before movement to the blast furnaces.

The use of plastic-coated corrugated sheeting for minimum maintenance, bays of translucent sheeting for interior light and louvers rather than windows for ventilation are improvements over the earlier Inland plants. Catwalks on both sides of conveyors are a safety convenience.

"LAYOUT AND DESIGN OF THE ASHLAND SINTERING PLANT"

by RICHARD W. ADAMS, Area Engineer—Blast Furnaces and Foundry, Ashland Works, Armco Steel Corp., Ashland, Ky.

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△ THE Ashland sintering plant is neither the world's largest nor the most automatic, but as a modern plant, capable of handling several raw materials and designed to furnish sinter for three widely separated blast furnaces, it is expected to be a very useful and economical tool. Built at a cost of approximately $5,500,000, it will produce 2400 tons per day at design capacity or 3000 tons per day maximum. Originating as an answer to the need of agglomerating the fines in Labrador ore, the plant will largely pay for itself by reclaiming an accumulated stockpile of flue dust and sludge.

Raw materials for the sinter mix, which are stored in bins and fed out by table feeders, consist of ore fines, flue dust, sludge, return sinter fines and coke. Current blast furnace sludge (as filter cake) and hot sinter fines are added on top of the other raw materials as they travel on conveyor belts to the pug mills and balling drum. The raw material handling system is designed to receive and store a day's requirements in eight hours.

The sinter machine has a maximum bed depth of 12 in. and an active hearth area of 807 sq ft. Pallet width is 8 ft 3 in. and the active length is 97 ft 6 in. with 15 windboxes. The main sinter fan will handle 200,000 cfm of air at 390 F and maintain a suction of 35 in. H_2O at the bed.

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"MONOLITHIC REFRACTORY CONSTRUCTIONS IN STEEL PLANT EQUIPMENT—PLASTIC AND CASTABLE REFRACTORIES COMPARED"

by GEORGE D. COBAUGH, Manager Specialty Sales, and CHARLES D. HAUTH, Technical Sales, Harbison-Walker Refractories Co., Pittsburgh, Pa.

G. D. COBAUGH

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tors in steel plants that are currently using monolithic refractory construction.

"CONTROLLING OXYGEN AND MOISTURE TO A BLAST FURNACE"

by J. L. WALLACE, Foreman, Steel Works Fuel Dept., Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

J. L. WALLACE

△ TO maintain a competitive position in the steel industry, it is necessary to operate all units as efficiently as possible. One manner in which this can be accomplished is through increased production on present equipment. Various methods and practices have been suggested, including blast enrichment and humidification. The Weirton Steel Co. has been successfully using oxygen and steam for this purpose for several years on four blast furnaces. Each furnace uses a single turboblower with associated controls and metering equipment. This includes a means of proportioning the oxygen, to the air blown, with a ratio regulator. The moisture content of the blast is sampled by a dew cell, sending a signal to a recorder-controller, which holds it to closely prescribed tolerance. Parallel piping arrangements for large and small valves and orifices provide a simple means of range shifting to meet the requirements of operations. This system has proved satisfactory and is regarded as a simple routine procedure from an operative and maintenance standpoint.

"OPENED COIL ANNEALING—A STEELMAN'S DREAM COME TRUE"

by LEE WILSON, Chairman of the Board, Lee Wilson Engineering Co. Inc., Cleveland, Ohio

LEE WILSON

△ FOR twenty years steelmen have been dreaming of a practical method of continuously annealing sheets and tin plate. Some success has been achieved in the hard tempers of tin plate, but no practical solution to the soft tempers of either tin plate or sheet had been found. The "opened coil system" is a radical break-through in annealing technique that makes possible extremely rapid and uniform annealing in either continuous or batch type furnaces.

Physical properties of low carbon sheets for extra deep drawing of superior characteristics can be achieved in a fraction of the normal annealing cycles. Either hard or soft temper tin plate can be annealed with equal facility.

The pilot plant which has annealed hundreds of tons of sheet and tin plate indicates that the opened coil system will give the following advantages over present annealing methods.

1. Superior physical properties.
2. Superior surface condition.
3. Lower labor costs.
4. Lower maintenance costs.
5. Lower fuel costs.
6. Much lower first costs.
7. Less than one-third of the floor space.
8. A saving of 90 per cent of the time spent in batch annealing.
9. A tremendous saving in process inventory.
10. Extremely fast service to customers.

All important new developments have some simple principle that makes them work. The principle or key to opened coil annealing is the simple method of opening up the coil so that every square inch of surface of the steel is exposed to the convection gases. This is done by rapidly wrapping between each wrap of the coil a nylon cord of about the same gage as the strip. After the coil is separated in this manner the cord is quickly withdrawn which leaves an equal opening between each wrap.

The area of an open coil is from 250 to 700 times the area exposed to heating in an unopened coil. This explains why open coils can be heated 10 to 12 or even 14 times as fast as hard coils.

Movies of the pilot plant together with drawings and models will show the details of the new system.

"INCENTIVE TRENDS IN THE STEEL INDUSTRY"

by JOHN C. CRAMER, Vice President, Albert Ramond & Associates, Inc., Chicago, Ill.

J. C. CRAMER

△ WAGE incentives, like many important management functions, involve decisions that have to be made by the individual company, in terms of its own cost objectives, production facilities, and competitive situation.

With the many types of incentives that are in use today, the problem of equitable incentive earnings requires an objective program with respect to incentive concepts, earnings potentials, and administrative practices. The resulting policies must be so eastablished that a trend for a better balance between the cost objectives and the labor relations climate can be achieved.

The establishment of new incentives, revision of existing plans, and the extension of incentives into other fields, provide interesting speculation as to future trends. Thus, management will face many challenging decisions in evaluating its future course in the light of past history.

"CONTROLLING MAINTENANCE COSTS"

by HAROLD B. MAYNARD, President, H. B. Maynard and Co., Inc., Pittsburgh, Pa.

H. B. MAYNARD

Δ A QUESTION frequently asked by cost-conscious managers is, "Can we do anything which will help us better to control and perhaps reduce our maintenance costs?" Since the ability to control depends upon the ability to measure, the question may be restated. "Is it possible to measure with any reasonable degree of accuracy the great number of miscellaneous, nonrepetitive, highly-variable jobs that constitute maintenance work and can we do it economically enough to make it worthwhile?"

A visit to a factory where up to date measurement methods are being used shows that this can indeed be done. The system used which has come to be known as Universal Maintenance Standards or UMS and the principles and procedures on which it is based are explained. The four factors essential to the success of the UMS plan are: (1) proper organization of the work, (2) properly developed work standards, (3) a qualified standards applicator, and (4) adequate training of the work force.

Each of these factors and methods of achieving it is discussed in detail.

The work measurement procedure is particularly important. With the aid of a device known as Standard Work Groupings, an applicator can establish a standard in about two minutes on the average and thus is able to establish standards covering from about 50 to 60 maintenance workers. At the same time, the standards he sets are sound standards which can be traced back to the basic motion patterns on which they are based if anyone wishes to question them.

With standards available, proper supervisory planning and control of maintenance work becomes possible. An example is cited of a group of carpenters who were found to be only 35 per cent efficient when standards were first applied. Within six months performance reached a level of about 90 per cent which is a reduction in cost of more than 50 per cent. This is typical of the kind of results obtained when maintenance work is organized properly, operators are trained in good methods, reasonable targets are set, and steady application to the work is made possible by eliminating the causes of interruptions. Basically the results are obtained not because the people work harder, but because they work more steadily and effectively.

"INCREASED COSTS OF PRODUCTION IN STEEL: THE PROBLEM AND POSSIBLE SOLUTION"

by WILLIAM T. HOGAN, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

Δ SINCE the close of World War II, there has been a definite upward trend in the costs of production in the steel industry. This increase has been the result of advancing prices paid for goods and services, as well as mounting labor costs. The price paid for purchased goods and services has increased considerably over the past ten years, while total labor costs per hour advanced almost 100 per cent between 1948 and 1957, rising from $1.68 per hour in the former year to $3.30 per hour in the latter.

W. T. HOGAN, S. J.

The increase in costs has necessitated a rise in steel prices which has placed steel in a less favorable position in relation to competing materials and certain imported steel products, such as barbed wire and concrete reinforcing bars. Further, the cost-price relationship with its upward spiral has brought the charge that the steel industry contributed substantially to the post-war inflation.

The total problem is serious, and shows every tendency to become more so in the next few years, if adequate measures are not taken to solve it. The solution does not rest entirely with the steel industry since much of the difficulty is a result of general inflation in the economy. This was proved when the steel industry tried to stem the tide of inflation in 1948 by reducing prices and withholding a wage increase from its workers. The attempt was a failure as other elements in the economy completely voided this effort. However, the industry can do much to solve its own problem. It can work to provide:

1. Some means to keep the increase in labor rates within the range of increased productivity or efficiency, an operation which would require the co-operation of organized labor.
2. The replacement of economically obsolete equipment with modern facilities.
3. More effective corporate organization and operation.

The paper will discuss specific remedies in each of these three areas.

"INCREASED PRODUCTION THROUGH ELECTROLYTIC TINNING LINE MODERNIZATION"

by DONALD H. JENTER, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio

D. H. JENTER

Δ THE maximum use of existing equipment has always been necessary in our increasingly automated society. But quite often in the past, equipment has been made prematurely obsolete in order to justify the purchase of newer, faster or more automatic machines necessary to keep pace with rising labor and overhead costs, and yet show a profit on the investment. Today, with a tightening economy, it is essential to look for ways to more wisely spend the fewer available dollars.

If new, high-speed, low-maintenance equipment is being considered to duplicate existing machine functions, one possible cost-saving approach is to rebuild, rather than scrap, existing machines. United States Steel Corp.'s Irvin Works plant near Pittsburgh offers a prime example of this approach in action. Here, the No. 3 electrolytic tinning line was recently modernized to increase line speed from 700 to 950 fpm, while maintaining the best possible speed, tension and position control.

Existing equipment was retained wherever possible. Modification of the drive system, including addition of helper motors and electronic, fail-safe motor control, and the installation of recoilers were the major changes.

The success of the modernization can be illustrated by the entry end, which can now accelerate a 30,000-lb coil from rest to 950 fpm in only five sec.

"A MODERN HIGH-SPEED TANDEM COLD REDUCTION TINPLATE MILL"

by NELSON W. HOCKING, JR., Chief Plant Engineer, Wheeling Steel Corp., Yorkville, Ohio, and A. F. KENYON, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

N. W. HOCKING, JR.

△ THE new 48-in. wide five-stand tandem cold reduction tinplate mill, put into service at the Yorkville, Ohio, plant of the Wheeling Steel Corp. in December, 1957, has 22,500 hp total main drive capacity, and operates up to 6000-fpm maximum nominal strip delivery speed. The mill is intended primarily to produce light gage (0.006 to 0.0125-in. thick) strip for tinplate, also some intermediate and heavy gage strip up to 0.035 in. thick.

The work rolls of stands No. 1 and No. 2 are driven through pinion stands by direct-coupled motors of 2000 and 4000-hp, respectively. The work rolls of stands Nos. 3, 4 and 5 are separately driven through step-up gears by twin-motors of 4000, 5000 and 6000-hp, respectively, and the winding reel is driven by a direct-coupled, triple-armature 1500-hp motor. Each stand and reel drive has a separate generator power supply, and the eleven main power supply generators, totaling 18,000 kw, are assembled on two motor-generator sets each driven by a 12,000-hp, 514-rpm, 13,200-volt synchronous motor.

A. F. KENYON

The two 75-hp motors on each stand screwdown have variable voltage control with magnetic amplifier regulator control of the supply generators, to provide maximum flexibility of operation, and to work into the automatic gage control on stand No. 1 and No. 5.

Automatic gage control is incorporated as an integral part of the mill control and regulating system to insure maximum uniformity of strip thickness and minimum length of off-gage strip. The strip thickness is continuously gaged and recorded and, through feedback signals, the mill is automatically adjusted to correct for variations in the entering hot strip. A thickness gage between stands No. 1 and No. 2 acts to control the No. 1 stand screwdown and assure uniform strip to the rest of the mill. A second gage, between stand No. 5 and the reel, measures the thickness of the delivered strip, and controls the No. 5 stand and the reel to vary the strip tensions and thereby maintain constant gage of the finished strip.

"MODERNIZING GRANITE CITY'S TANDEM COLD MILL—FROM A 1946 MODEL TO A 1958 MODEL IN THREE WEEKS"

by A. W. SCHLECHTE, Chief Electrical Engineer, R. G. NOLAN, Electrical Engineer, Granite City Steel Co., Granite City, Ill., R. M. PEEPLES, Supervisory Engineer, Control Dept., and D. E. REA, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

A. W. SCHLECHTE

RICHARD G. NOLAN

R. M. PEEPLES

D. E. REA

△ A PROJECT calling for substantially increasing production of an existing tandem cold mill, with a minimum of downtime on the mill, was completed earlier this year at the Granite City Steel Co., Granite City, Ill.

A preliminary study was made based on future sales requirements, product mix and maximum torque capabilities of the existing mill. Maximum rolling speeds, expected tonnages and horsepower requirements were thus established. These requirements were modified slightly to make the best possible use of existing equipment and to keep costs and production loss at minimum values. Total drive horsepower was increased from 9600 to 18,700 hp.

A maximum employment of prefabrication and preinstallation technique was the primary consideration used in engineering and planning the change. The use of steel beams as motor bases in place of the more common concrete construction is but one example. The control equipment is located in the basement directly beneath the main drive motors. A false ceiling was employed during motor installation allowing new bus work and other control changes to be made during motor installation while the mill was still in use. Changes of the mill stands and oil cellar also had to be made. Planning of the work in these three areas had to be dovetailed so they would be completed simultaneously. The control regulating

system was also switched from rotating amplifier to 400-cycle static amplifiers during this same period.

Originally five weeks were scheduled for complete shutdown of the mill to install the new equipment. Orders were rolled on a 20-turn basis to obtain the necessary stock pile of cold reduced product which would enable the other departments dependent on cold rolled steel to remain in production.

The mill was shut down March 17, 1958, and the first coil for restarting mill was rolled the morning of April 7, 1958. Commercial product from the first turn after start-up is the satisfactory reward of a thoroughly planned conversion.

"UTILIZATION OF BY-PRODUCT FUELS"

by R. W. WORLEY, Chief Power Engineer, and R. H. GHERST, Senior Power Engineer, United Engineers & Constructors Inc., Philadelphia, Pa.

R. W. WORLEY

△ THIS paper outlines the need to make the best possible use of by-product fuels available in integrated steel plants. As a user of coal in excess of 100,000,000 tons annually, the steel industry has a vital interest in conserving this supply, plus the added incentive of possible savings from effective utilization of these products.

Two avenues of approach to conservation of fuel are outlined: (1) decreasing basic use of fuel in blast furnaces, and (2) effective use of by-product fuels to minimize use of other purchased fuels.

Average figures have been developed to indicate how the component elements of a ton of coal are first prepared in the coke plant to produce gaseous and solid products for further use in the mill. The gas is then processed to yield other by-products which include tars, benzene, ammonia and ammonium sulphate, and the coke is used in blast furnaces.

R. H. GHERST

The use of coke oven gas for heating coke ovens and other metallurgical processes, including firing of open hearth furnaces, and as boiler fuel is discussed.

Coke breeze is a satisfactory boiler fuel when burned in properly designed furnaces; however, recent development in the use of sintered ore provides a much more profitable use of this material. This has created a demand for breeze which has virtually wiped out coke breeze stock piles.

Blast furnace gas is perhaps the most voluminous by-product available. Although the heat content is low, the net quantity available encourages its use as boiler fuel or underfiring of coke oven batteries.

The use of blast furnace gas in internal engines for blowing engines or power generators has long been general practice. However, heavy maintenance costs and demands for larger capacities have made this type of equipment obsolete. The gas turbine is a potential user of blast furnace gas, and developments now under way will furnish ample data for further study.

"THE TWIN PILLARS OF PROFIT—BLAST FURNACES AND POWER"

by AUSTIN E. McDONOUGH, Division Superintendent, Blast Furnaces, and GEORGE H. KRAPF, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

A. E. McDONOUGH

△ THE first cost in an integrated steel mill is for hot metal conversion and power.

The two functions of producing hot metal and power are closely interrelated. The production and delivery of blast furnace gas affects the cost of power production, which in turn affects hot metal costs, as well as all other conversion costs.

Close co-operation between the personnel of these two functions results in lower costs.

Methods of achieving the desired degree of co-operation include:

1. The education of supervisors through lectures, distributed literature and co-operative studies.
2. A free exchange of information between functions concerning methods of solving similar problems.
3. Co-operative efforts through the establishment of formal working procedures by the personnel involved, in order to improve production and maintenance techniques.

GEORGE H. KRAPF

Both operating units have gained in knowledge and effectiveness as understanding between the units grew. The effectiveness of co-operation may be measured by improved blast furnace gas deliveries, and lowered utilities costs.

Examples of actual activities are given, and the results are evaluated. The results tend to show that the method used at South Works points the way to achieving teamwork between operating units for cost reduction.

"ATOMIZATION OF OPEN HEARTH FUEL OIL WITH HIGH PRESSURE GAS"

by J. D. WELLS, Open Hearth Engineer, and GUY L. ROGERS, Works Engineer, Sheffield Div., Armco Steel Corp., Houston, Texas

J. D. WELLS

△ THE Houston plant of Sheffield Div., Armco Steel Corp., changed from atomizing open hearth fuel oil with steam to atomization with high pressure natural gas. Investigations indicated that by eliminating the steam, higher flame temperature could be obtained and also substantial fuel savings effected by firing a greater proportion of gas to oil. The flame appearance with

high pressure gas is a shorter, brighter, less dense flame than when atomizing with steam. Checks indicate that the high-pressure gas flame is 3 per cent hotter than the steam atomized flame.

In the process of installing the equipment for high-pressure gas, considerable changes were made in piping, flow controls and reversal system. These changes are described.

G. L. ROGERS

The effect of atomizing with steam and atomizing with 200 and 250 psig natural gas is discussed.

A control problem was presented in the change to atomization with high-pressure gas because of the necessity to meter a certain rate of atomizing fluid and also maintain constant pressure at the burner for uniform flame characteristics. Several measures were taken to control these pressures.

The velocities in the atomizer tube were greater with the steam than the natural gas. This disadvantage is overcome by using a greater portion of atomizing fluid per gallon of oil. There is also a greater weight of fluid flowing with steam than the natural gas, thereby giving a greater thrust with the steam. This disadvantage is compensated for by replacing the inert steam with the combustible gas.

Comparisons are made of the tons per hour, Btu's per ton and refractory life of the furnaces using steam atomized burners with furnaces using high-pressure gas atomized burners.

"CYCLIC WELDING METHOD SALVAGES HEAVY MILL EQUIPMENT"

by R. L. RECTENWALD, President, Maintenance Engineering Corp., Pittsburgh, Pa.

R. L. RECTENWALD

△ THE cyclic method denotes a newly developed welding procedure which is not limited in the mass of weld metal deposit or in the thickness of members joined. Weld metal is deposited to a predetermined thickness and temperature stress relieved in repeated cycles until the desired deposit is completed free of residual welding stresses. This technique has been proved over several years in effectively welding mill housings, drive spindles, pinion necks, crankshafts, forging equipment and similar metalworking equipment. Many of these items were welded in highly stressed areas heretofore considered not weldable. The cyclic procedure has superseded the thermit welding procedure in practically all applications with many proved advantages such as cost, quality of weld, position and physical properties of alloy, and high carbon forgings can be matched.

Practically every type of heavy metalworking equipment and component parts have been restored by the technique. Recurrent failures have been negligible and such factors as alignment and internal cracking are under control at all times. A few of the features underlying the success of the method are:

1. Repairs or weldments can be effected using composite materials where desirable.
2. Critical areas can usually be welded with a sound weld material of high strength replacing a weaker material which often contains an obvious flaw.
3. Large fillets can be formed to replace sharp corners and other stress risers.
4. Areas subject to tension can be prestressed by peening and prestressed in compression to alleviate recurrent failure in tension.
5. Design changes can be incorporated to provide reinforcement where desired.
6. The original normalized or stress relieved condition is restored to eliminate possibility of other highly fatigued areas which may have developed during the operating history of the equipment.
7. Certain deficiencies found in thermit welding are avoided by use of the method such as internal cracking, porosity, piping, sand and slag inclusions, hot metal handling hazards, extremely low ductility, low strength and poor machinability.

In conclusion, a new plateau has been reached in the development of metal joining techniques and a wide range of applications lies ahead in the fabrication and repair of heavy welded sections.

"ORGANIZING A STEEL PLANT PREVENTIVE MAINTENANCE PROGRAM"

by RICHARD F. ARMITAGE, General Superintendent, Warren District, Republic Steel Corp., Warren, Ohio

R. F. ARMITAGE

△ NEGLECTED maintenance results in costly repairs. This premise prompted Warren District of Republic Steel Corp. to organize a preventive maintenance program some ten years ago. The initial objective was the development of adequate and systematic inspection procedures. Assigned maintenance personnel were indoctrinated with the prevention concept by requiring millwright group leaders to revise their turn activity reports to include conditions that might result in delays as well as accounts of actual troubles encountered. Emphasis was placed on their responsibility to keep machine elements well lubricated and securely fastened together.

Inspection check lists were compiled listing major pieces of mill equipment and their components.

A qualified machinist with suitable field experience was assigned to full time inspector duty in the 42-in. hot strip mill. His findings were recorded on these check lists and submitted to all concerned with taking corrective measures indicated. By this means, the mechanical delays in this mill were appreciably reduced in a period of about ten months. Gradually, as conditions permitted, the inspection report frequency was reduced until finally the whole inspection function was transferred to the departmental mechanical foreman and the machinist inspector moved on to set up the same procedure for other production units. Today all depart-

mental mechanical supervision throughout the district compile and submit such inspection reports according to a predetermined perpetual schedule.

The use of nondestructive testing devices was integrated into this inspection procedure. Highly stressed parts such as pinions, roll wobbles, spindles, etc., are periodically examined with a reflectoscope to discover any internal "fatigue" condition which might result in breakage and downtime.

The records of such tests are one of the factors studied by a Preventive Maintenance Committee, whose purpose it is to prolong the useful life of machinery components by recommendations as to improvements in design, lubrication and operation of the processing equipment.

Finally, a concerted effort has been made and is still under way to intelligently acquire and properly store and control spare parts. By charging the departmental mechanical foreman not only with the responsibility for procuring and storing such commodities, but also of keeping adequate and up to date inventory records of them, he is able to better evaluate and improve the relative service performance of the different kinds, grades and makes of equipment he uses.

This, like any such program, requires the combination of the training, skill, determination, interest and cooperation of many people to make it work successfully.

"COST ESTIMATING—METAL WORKING PLANTS"

by A. J. MOSSO, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

A. J. MOSSO

△ PERHAPS the most perplexing problem a mill engineer will ever be called upon to solve during an entire career is his first attempt to estimate the costs of a major plant expansion before any engineering is completed. This would include estimates made for appropriation purposes and, if done in sufficient detail, could be used as a basis for a cost control scheme. Emphasis is placed on the construction or installation of the program since it is here that the mill engineer encounters the most difficulty.

It is not the intention of this paper to cover the detailed and accurate but time consuming methods used by contractors in arriving at prices for bid purposes after the construction engineering is reasonably complete. The paper is intended to be of assistance to the mill engineer who must make cost estimates long before the equipment is purchased and before the engineering has progressed beyond general arrangements of equipment.

The author begins with a discussion of the information that must be assembled for the estimate and points out the main sources of information and help which can easily be obtained.

This is followed by assuming a fictitious project and outlining the components of the job with the quantities and unit prices used to arrive at a total cost for each major phase of the job. All factors of an estimate from site preparation to the contingencies are covered in the discussion.

The estimate is followed by a brief discussion of the accuracy which can be obtained by the method outlined. Sign posts and guides are given which prevent an estimator from making major errors of omission or commission.

The paper also touches briefly on the relationship between the cost estimate and the construction engineering. The importance of proper direction of the project and its effect on an early estimate is brought to light. The author also touches briefly on the more important economies which can be incorporated into a project to keep costs in line without reducing the quality of the program.

"RECENT ACTIVITY CONCERNING ANTI-FRICTION ROLL NECK BEARING DESIGNS AND MOUNTINGS"

by E. C. DENNE, JR., Manager, Rolling Mill Dept., SKF Industries, Inc., Philadelphia, Pa.

E. C. DENNE, JR.

△ THE development of a new anti-friction rolling mill, roll neck bearing—the "multi-row" cylindrical—was covered in a paper given at the April, 1956, AISE spring meeting. See 1957 Proceedings AISE. It is the purpose of this paper to show how this standard cylindrical bearing design, joined with suitable thrust bearings, may be engineered into custom roll neck mountings to satisfy specific types of rolling requirements.

The basic multi-row bearing is reviewed to give a better understanding of the standard design to which the many possible variations may be applied. Although originally developed as a tapered bore, tight neck fit mounting, a straight bore, loose neck fit design has now been developed for those mills not requiring the advantages of the tight fit. Special treatment of the straight bore which precludes scoring the bearing bore and roll neck due to creep is reviewed.

Specific mountings and related subjects are discussed as follows:

1. Demonstration of sine bar gages for manufacturing tapered necks.
2. Demonstration of hydraulic mounting and removal for making and releasing the tapered bore "multi-row" tight neck fit.
3. Roll neck bearing ratings.
4. Changeover from loose neck fit roller bearings to the tight neck fit "multi-row" cylindrical on a 20 and 48 x 84 in. temper pass mill.
5. Improved multi-strand, high-speed rod mill roll neck bearing mounting.
6. Straight bore "multi-rows" for a new 40 in. blooming mill.
7. New "multi-row" bore grinding machine, thought to be the biggest of its type.

8. Possibilities of a new "O" ring seal design.
9. Report on studies of a combination cylindrical, tapered roller work roll bearing design.

"MAINTENANCE OF MILL OIL BEARINGS"

by C. A. BAILEY, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. COOPER, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

C. A. BAILEY

△ MAINTENANCE procedures for the two normally used oil bearings are presented. The procedures have been selected in part from industry practices and in part from manufacturers' recommendations; they are presented to obtain optimum bearing maintenance by establishing guides.

Shop conditions and maintenance procedures that are conducive to the attainment of optimum bearing life are offered. Recommendations for roll and bearing shop practices are made; ideal locations and conditions of these shops are noted. Solutions to common occurrences involving the maintenance and installation of the mill oil bearings are considered, as are the instruments and methods of checking various parts.

The selection and care of a lubricant for mill oil bearings are reviewed. A bearing manufacturer's lubricant requirements are noted, as are a consumer's benchmarks. Various laboratory tests are illustrated. These tests may be employed for the selection and evaluation of a new or used lubricant.

A. C. COOPER

"AN APPROACH TO WIRE ROPE LUBRICATION"

by LOUIS A. STANZIONE, Engineer, Williamsport Plant, Bethlehem Steel Co., Williamsport, Pa.

LOUIS STANZIONE

△ WIRE rope is usually a working part of machinery and as such requires proper lubrication if it is to operate efficiently and render a maximum amount of service.

In the past, wire rope lubricants were bought and sold more or less as a "matter-of-fact item" and their behavior under field conditions was not known until ropes were lubricated and placed in service.

Recently, rather simple but effective laboratory tests were developed and used to evaluate the performance of wire rope lubricants. These tests consist of a high and low temperature test, and a stripping or adhesiveness test. The results of these tests have been very favorable in predicting the behavior of the lubricant under field conditions.

Once a lubricant has been selected for use, then it is vitally important that it be applied to the wire rope at the proper temperature.

The lubricant applied during manufacture of the rope is not intended to provide adequate lubrication for the entire life of the rope and therefore field lubrication is necessary to insure maximum service.

"RECENT DEVELOPMENTS IN PIPE AND TUBE MILL MACHINERY"

by DIETER HANCKE, Vice President—Sales, and ROBERT HARTENSTEIN, Vice President—Engineering, Mannesmann-Meer Inc., Youngstown, Ohio

DIETER HANCKE

△ VARIOUS recent design developments in the field of equipment for seamless tube mills include a new small diameter high torque capacity piercing mill roll spindle coupling with provision for fast disconnect and exchange of universal joint slippers, a radically new single groove roll plug mill with entirely open and easily accessible inlet side and with a unique direct roll drive by individual d-c motors with acceleration during the rolling time, a new type of individual reeler roll drive by slipperless universal joint spindles, two new sizing mills of unconventional design with fast schedule change features, and a 3-roll type, 12-stand reducing mill for rerolling of seamless tubing stock under highly flexible schedule pattern conditions.

ROBERT HARTENSTEIN

A radically new type of stretch reducing mill with a hydro-mechanical variable speed drive adds program flexibility and extremely short schedule changeover time to the inherently high tonnage capacity of electric resistance pipe welding mills for the production of hot finished pipe at constant output through full size range. High accuracy of cut and simple design characterize a newly developed flying hot saw installed behind a stretch reducing mill to separate strand of pipe rolled from 190-ft shells. A fully automatic elongation measuring device permits accurate reading and control of wall thickness of pipe while being rolled in stretch reducing mills.

In the field of pipe finishing equipment a new design for fast automatic pipe transfer tables was developed for use with cut-off machines and automatic x-ray wall gaging equipment.

New designs have been introduced to the field of cold working of tubing and pipe. A unique 7-roll straightener permits triple deflection one-pass straightening of plain end pipe and oil well tubing with externally up-set ends, and features ease of setup and fast roll changes. Cold outside diameter reduction for resizing after heat treatment and for increase in physical properties of carbon steel pipe is performed on new

type 3-roll cold mills with close stand spacing at high speeds. High-speed multiple drawing of steel and nonferrous tubing is the result of the introduction of a new wire rope drive for draw and carriage return cycles on cold draw benches. The development of a mechanically compensated drive for cold pilger mills has practically doubled production capacities of this equipment for cold rolling of stainless and carbon steel as well as nonferrous tubing.

"RECENT DEVELOPMENTS IN DESIGN AND CONTROL OF HOT STRIP MILLS"

by RICHARD W. BARNITZ, Chief Electrical Engineer, and H. H. SHAKELY, Plants Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. W. BARNITZ

△ JONES & Laughlin Steel Corp. has recently installed a new continuous hot strip mill at Aliquippa works which includes a reversing roughing mill. The four roughing stands on the continuous hot strip mill at Cleveland works have been replaced with a reversing roughing mill. The advantages of the reversing mill over the multiple stand roughing mill are numerous but this type of installation, although less in total cost, requires the best in mechanical and electrical design. The mill must keep the finishing train full of steel and therefore the rolling speed must be the maximum and the mill reversal time must be held to a minimum. In order to meet these requirements, both mills were completely programmed with a punched card system. The programming systems are functionally similar but of different design, the one system reading the complete information on the card and storing it for use as required, whereas the other system reads the information off before each pass. The mechanical and electrical problems encountered in the operation of the mill are discussed.

H. H. SHAKELY

"LONE STAR STEEL'S NEW STRETCH-REDUCING MILL"

by LEONARD ELLER, Superintendent, E. W. Pipe Mills, Lone Star Steel Co., Dallas, Texas

LEONARD ELLER

△ ON January 7, 1958, production was initiated on Lone Star Steel's stretch reducing mill which, through its unique reduction process, permits the fabrication of tubing and smaller size casing and line pipe from the company's No. 2 electric-weld pipe mill product at tonnage rates equivalent to maximum welding mill speed.

Welded pipe lengths up to 200 ft long are transferred by coupled three section chain conveyor tables and conveyed through normalizing and reheat furnaces before entering mill proper.

After outside diameter and wall reduction is accomplished, the tube is automatically sawed to desired lengths, and they are kicked off onto a screw type cooling bed where nominal lengths are transferred to further sizing, straightening and finishing functions.

Outstanding features of the mill are elimination of all roll adjustments, quick change device for roll stands, flying saw and length measuring electronic control, hydraulic drive and extremely accurate speed control.

Units are duplicated throughout the construction of the mill. Each stand has four separate components, the stand bevel gear unit, the hydraulic drive, the differential drive, and the stand speed reduction unit, and all of these units are interchangeable for any of the stands with the exception of the stand speed reduction unit.

With plans for the addition of two roll stands in process, and the recently enlarged ingoing pipe size range to 6⅞ in. outside diameter, the tonnage and reduction potentials of the mill will be further enhanced.

Each day of stretch mill operation at Lone Star Steel Co. results in added realization of the tremendous flexibility of this process when coupled with an efficient electric welding mill line production.

"STANDARDIZATION OF LUBRICANTS FOR STEEL MILLS"

by P. D. METZGER, Associate Research Engineer, Lubrication Testing Laboratory, and H. D. FOSTER, Standards Engineer, Wheeling Steel Corp., Wheeling, W. Va.

P. D. METZGER

△ THE standardization of the lubricants for use in steel mills has been undertaken with varying degrees of success and vigor by numerous steel companies. The values to be realized by lubricant standardization are multiple, but all can be summed up as reduced cost, both in operations and in purchase price.

The when, where, why and how of lubricant standardization are often de-emphasized in an analysis of the results achieved.

Wheeling Steel Corp. has been actively pursuing lubricant standardization for over four years. This paper describes in detail the standardization program of Wheeling Steel and develops their answers to this when, where, why and how. Each phase of progress from the original inception of the idea to standardize to the present are reviewed. A specific type lubricant will be singled out and the procedures followed by Wheeling Steel in standardizing thereon are developed in detail. The relationship of laboratory tests to field

H. D. FOSTER

conditions are also discussed, not with the intent of education on laboratory procedures, but rather to point out the experienced correlation of laboratory tests in relation to field requirements.

The values of the program are reviewed, and the question, "Has standardization of lubricants paid, in cold, hard cash?" is answered.

"CONSIDERATIONS FOR THE APPLICATION OF FIRE RESISTANT FLUIDS"

by C. T. LEWIS, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

CHARLES T. LEWIS

Δ THE primary considerations involved in determining the use of a fire resistant fluid include: (1) basic need, (2) toxic considerations, (3) flammability, (4) physical attention, (5) solubility of contaminants, (6) operating pressure, (7) type of pump, (8) wear characteristics, (9) operating temperatures, (10) ambient temperatures, (11) fluid viscosity and (12) economics.

Multiple relations of the above items will affect the final choice of equipment and fire resistant fluid to be used.

Various examples are given of problems which can arise in the use of different fluids which may be the direct result of physical or chemical changes within the fluid itself or which may be an indirect result in the fluid as a consequence of other mechanical or physical conditions.

"MICROCHEMISTRY IN LUBRICATING OIL ANALYSIS"

by F. M. ROBERTS, Supervisor, Analytical Dept., Texaco Research Center, The Texas Co., Beacon, N. Y.

F. M. ROBERTS

Δ MICROANALYTICAL techniques have become very important tools in the analysis of lubricating oils, both used and unused. Although the techniques were developed primarily in biological studies, they have been readily adapted to the field of petroleum analysis. The petroleum analyst depends upon both physical and chemical tests in the course of his examination of a lubricant. Many of the chemical tests developed by the first workers in the microchemical field are applicable directly to his problems, but he has had to develop his own physical test techniques. The term microanalysis is applied to techniques involving ten milligrams or less of sample, however, the definition is not strict and the term is often applied to larger samples.

Specific tests which might be used to characterize an oil are gravity, pour point, viscosity and additive content. These plus others which might be required can all be done on the micro scale. Since many tests are nondestructive, considerable information may be obtained on one or two drops of sample. Microanalytical techniques are particularly valuable in the analysis of used lubricants where contaminants or deposits are involved. There are often only small amounts of these available which makes micro techniques imperative.

Many analytical techniques not usually thought of as such, are in reality micro procedures. Examples are various instrumental techniques. The future holds promise of more difficult problems for the micro-analyst. The increasing complexity of modern lubricants and machines will result in problems which can only be solved by micro procedures.

"DEVELOPMENT OF A NEW HORIZONTAL FLOW, PLATE TYPE PRECIPITATOR FOR BLAST FURNACE GAS CLEANING"

by BENGT R. BERG, Manager, Precipitator Div., AB Svenska Flaktfabriken, Stockholm, Sweden

B. R. BERG

Δ IN Europe horizontal flow plate type precipitators are used frequently for the cleaning of blast furnace gas and the reasons for this are discussed in this paper. The development of a new type of such a precipitator took place in three stages. The first involved tests with a model precipitator. Based on these tests two full scale units were built as second stage. On these full scale units the cleaning of the interior parts by means of water flushing was studied. This study gave an idea for a new flushing arrangement which, as stage three, was incorporated in the construction of additional full scale units. This new type of precipitator which now is in operation and under construction in various European countries has given good test results and the paper contains some of these as well as operational experience obtained. The precipitator can be designed for high collecting efficiencies and for high inlet dust concentrations. The paper also gives some examples showing how this precipitator has been adopted for various requirements and arrangements. Finally, the experience with the electric equipment is discussed.

"PERFECTED AND PRACTICAL METHODS OF PROCESSING POWDER INTO COMMERCIAL STRIP"

by RICHARD A. SMUCKER, Application Engineer, E. W. Bliss Co., Salem, Ohio

R. A. SMUCKER

Δ THE conversion of metal powder to strip by continuous roll compacting, sintering and hot rolling is both practical and economical for certain classes of metal powder.

Chemical methods perfected for producing high-grade metal powders directly from scrap or ores resulted in stirring up interest in the possibility of conversion of metal powders directly to strip.

The continuous conversion process applicable to commercial plant operation uses special designed rolls for compacting metal powder to a uniform density green strip of sufficient strength to permit easy handling. This green compact is sintered, hot rolled and reeled into coils of essentially 100 per cent dense hot rolled band.

The hot rolled band from the conversion line can be cold rolled successfully to thin gage strip. The mechanical properties of copper strip, for example, produced by this method show tensiles and yields that average higher than electrolytic grade copper with elongations equal to electrolytic grade copper. The oxide content of the copper strip from powder is much less than that reported for commercial grade electrolytic copper. Hence, this copper is less susceptible to hydrogen embrittlement and is more easily welded. These factors, together with the small uniform grain size, result in copper strip that is ideal for deep drawing and forming operations.

This process is applicable to most metal powders and may be the answer to the fabrication of some of the "miracle" metals and special alloys that resist conventional methods of production.

"THE STRATEGIC-UDY DIRECT IRON REDUCTION PROCESS"

by DR. MARVIN J. UDY, Vice President, Strategic-Udy Processes, Inc., Niagara Falls, N. Y., and ROBERT A. BLACKBURN, Sales Engineer, Koppers Co., Inc., Pittsburgh, Pa.

DR. M. J. UDY

△ THE Strategic-Udy process for the direct reduction of iron is a variation of established electric furnace smelting techniques. The process utilizes a rotary kiln for prereduction of iron ore before charging to an electric smelting furnace. The use of prereduction lowers the power requirements of the electric furnace smelter, thus permitting the process to compete with established methods of iron ore reduction. Electric furnace smelting without prereduction has been successful in areas of the world where power costs are low and good coking coal are either not available or their cost is prohibitive.

R. A. BLACKBURN

While the combination of prereduction in a rotary kiln, coupled with an electric furnace smelter is not new, there are several unique features of the process that sets it apart from other similar combinations of prereductions and electric furnace smelting. The significant difference lies in the operation of the electric smelting furnace in that the furnace operates with a floating charge instead of the customary submerged arc. The electrodes penetrate the molten slag from ½ to 3 in., depending upon the particular characteristics of the molten bath. Part of the charge material enters on the periphery of the furnace and forms its own angle of repose thus the space above the electrodes is open and offers no restriction to the flow of carbon monoxide gas produced during the reduction reaction. The use of such operating techniques permits the charge of fine ores without interference to the operation as well as relative insensitivity to the type of reductant. A particular desirable feature of the process, due to the floating charge technique, is the control of carbon in the iron. It is possible to vary the carbon content of the iron from 0.2 to 3.5 per cent carbon with comparative ease. Another significant advantage of the process is its ability to process iron ores contaminated with impurities such as titanium, manganese and chromium.

The paper gives typical examples of calculations for obtaining the material and energy requirements using various iron ores. In addition economic analyses show the manner in which various factors affect the manufacturing costs of the process. The cost of reductant as well as the cost of power are examined with respect to their effect on the economic utilization of the process.

Preliminary capital cost estimates of the process direct reduction plants are discussed as well as comparisons with other established methods of iron production.

"PRESENT SITUATION OF JAPANESE STEEL INDUSTRY"

by KICHIRO SAIGO, Manager of New York Office, Yawata Iron & Steel Co. Ltd., New York, N. Y.

KICHIRO SAIGO

△ IN 1957, the steel industry of Japan produced 12,570,000 metric tons of crude steel, enabling Japan to rank sixth among the world's steelmaking countries. The outstanding characteristics of the present Japanese steel industry, comparing with that prior to 1945, are: (1) it consists of entirely free enterprise; and (2) it has closer relation with the United States of America. It depends upon the U. S. for most of the raw materials it must import; such as large percentages of coking coal and scrap, and for some of the ore. Much of the modern equipment in operation is of U. S. origin, and the technological progress has been made possible by the cooperation with American steel companies.

Since the heavy and chemical industries tend to have growing weight in the Japanese industrial structure, a greater importance has been laid on steel as one of the basic commodities as well as one of the main export items. The recent development in shipbuilding, machinery and consumer durable goods manufacturing has brought a big increase in requirements for steel, especially for flat steel products.

Japanese steel industry was behind those of the United States and European countries in starting modernization of equipment. However, the first modernization program started in 1951 whose emphasis was mainly on renovation of rolling facilities has resulted in an improvement of operation techniques and a notable decrease in unit consumption of materials and energy.

The second program is under way and projects are undertaken not only for addition of new blast furnaces

and converters to the existing units, but for construction of integrated plants at new sites. The present program will push up the Japanese steel output to 20,000,000 tons in 1962. Loans from the Export-Import Bank of Washington and the World Bank are playing an important part in the construction works.

Under the present world-wide economic recession, an inventory adjustment is being made in the industry and a little slowing down of production is unavoidable. Steel production in 1958 may stay slightly below the 12,000,000-ton level. However, efforts are being made constantly to increase steel exports, and to bring down the cost of raw materials by construction of ore carriers and by expansion of harbor facilities.

"THE VENEZUELAN STEEL WORKS"

by M. GONNI, Manager, Engineering and Construction Div., Innocenti S.G., Milano, Italy

M. GONNI

△ THE Venezuelan government committed to an Italian firm, the Innocenti S.G., Milano, the design, construction and erection of an integrated steel plant, located on the right bank of the Orinoco River, near Puerto Ordaz at the confluence with the Caroni River.

A preliminary study was made in 1955 by F.I.A.T., Torino, for a plant of 400,000 ingot tons per year. In early 1957 the Venezuelan government agreed to increase the plant capacity up to 700,000 tons per year (with future provisions up to 1,500,000 tons).

Studies for a new design were immediately started in Milano by our company and the ground was broken on the plant site in March, 1957.

The purpose of this plant is to manufacture the steel products most needed by Venezuela which up to now have been imported, mainly from the U. S.

Venezuelan raw materials will be used in the manufacturing processes. Availability of low cost hydroelectric power and a coal not fit for blast furnace operation have determined the choice of electric reduction furnaces for making pig iron. Steel will be made in four 250-ton open hearth furnaces: a small amount of outside scrap will be also used. The rolling mill department consists of:

- A 44-in. blooming mill.
- A three-stand, 800-mm diameter reversing mill, for manufacturing rails, structurals and billets.
- A 300-mm diameter semi-continuous mill, for small sections, rod and wire-rod.
- A three-stand, three-high, 500-mm diameter mill, for medium section.

A seamless pipe manufacturing department will give about one-half of the total steel finished production as pipe from 1½ to 24-in. diam. The pipe will be used mainly in the oil industry, the reinforcing rods and the sections in the civil works program.

The plant is completed with all the auxiliary services and facilities. An iron foundry for spun iron pipes and for ingot molds as well as a wire drawing mill are also included in the plant.

An unloading pier is under construction on the Orinoco River: all the raw materials will come through it and all the shipments will be made from there. The navigability of the Orinoco river all around the year allows the use of this waterway for the plant operation.

The author's company will supply the pipe mills, a large part of the other rolling mills and some facilities, is the designer of the entire project and the prime contractor for the whole job.

The works started in March, 1957, and will be completed by June, 1960.

"COMPANIA DE ACERO DEL PACIFICO—CHILE, ITS INCEPTION AND GROWTH"

by JUAN ZAPATA, Vice President, Representative in U. S. A., Compania de Acero del Pacifico, New York, N. Y.

JUAN ZAPATA

△ ONE of the first objectives of Corporacion de Fomento de la Produccion (CORFO), a Chilean Government agency to promote industrial development, was to find a solution to the Chilean steel problem.

With appropriate raw materials in the country, i.e., ore, coal and limestone, satisfactory quality of which was ascertained by European and North American firms specializing in steel industry problems, CAP (Compania de Acero del Pacifico, S.A.) was organized in 1944 with $15,000,000 capital.

After the steel plant had been projected, a proposal was submitted to Eximbank of Washington, for a long term loan, to assist in financing the project. Chilean firms entered into the company and a total of $79,000,000 was raised to finance the construction of Huachipato. This started in the middle of 1946, near Concepcion about 300 miles south of Santiago, the capital of Chile. In 1950 the plant went into operation with a pier to unload ore and coal, one battery of 57 coke ovens, one 500 ton per day blast furnace, bessemer converter, a two-unit 75-metric ton open hearth shop with a capacity of 236,000 metric tons, rolling mill capacity of 100,000 metric tons for merchant products and 60,000 metric tons for flat products.

In 1952, an expansion and broadening of the plant took place with an investment equivalent to $15,000,000, U. S. raising steel making capacity to 280,000 metric tons, representing an 18 per cent increase over the original steel capacity, and to 200,000 metric tons the finished products capacity. Along with these additional facilities, changes in practices and improvement of techniques and training of personnel enabled steel capacity to be increased to 360,000 metric tons, by 1953.

The growing Chilean market compelled the company to launch a $40,000,000 expansion, development and cost reduction program in 1956 of which roughly 50 per cent is being financed by Eximbank and the balance by CAP's own funds. The improved plant will produce 430,000 metric tons of ingots and will be able to process 350,000 metric tons finished products. Among the new units are a fourth 200-metric ton open hearth

a 4-high hot reversing mill, a 3-stand cold reduction mill, a temper mill and the usual auxiliary strip processing facilities exclusive of electrolytic tinning, continuous galvanizing and annealing.

Sales policy is directed to supply the Chilean market with products at, at most, the same basic cost of imported product. Due to the restriction of the industrial activity, mainly the construction industry as a result of anti-inflationary measures in 1955, CAP has been compelled to export up to half of its production to the neighboring countries, competing successfully with European steel products. It is expected this situation is temporary since the primary objective is to develop and supply the domestic market.

CAP has strengthened the Chilean economy by making available a basic product. It has also saved Chile a large volume of exchange and increased the trade with the U. S. A. by investing large sums of dollars in supplies and capital equipment in the U. S. A., over and above the spending of the loans in this country.

This young company has furthered the modern conception of sound management principles and practices, and has applied a keen interest in human problems. The confidence that its employees have in their company can be appreciated by the fact that more than 3000 of its employees constitute a large part of CAP's 7180 stockholders.

"MODERN REGENERATIVE SOAKING PITS"

by HENRY S. HALL, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

H. S. HALL

Δ DURING the last four or five years the regenerative soaking pit has been modernized quite extensively and instrumentation has been applied to it so that it is now a fully automatic heating furnace.

Soaking pits have been built recently to burn the entire range of fuels from straight blast furnace gas through mixed blast furnace and coke oven gas on up to straight natural gas and Bunker Coil.

The paper covers designs and installation of over 100 holes of modern regenerative soaking pits over the past four or five years.

"SPECIAL FEATURES OF STELCO'S NEW SOAKING PITS"

by E. T. W. BAILEY, Chief Combustion Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

E. T. W. BAILEY

Δ THE block of soaking pits recently installed to serve The Steel Company of Canada's new 46-in. blooming mill include a considerable number of interesting design and control features.

The paper deals with a general description of the principal features including servicing areas; control panel arrangement; fuel selection for individual pits; automatic heating finish using blast furnace gas; burner design using rich to lean gaseous fuels; temperature control of steel and atmospheric combustion air supply; means to balance waste gas flow through recuperators; a very general description of the fuel control system used; and various measures taken to improve control maintenance.

The paper is accompanied by many photographs and sketches.

"HEATING FACILITIES FOR YOUNGSTOWN SHEET AND TUBE'S NEW SEAMLESS MILL"

by F. C. McGOUGH, Superintendent of Fuel and Power, Youngstown Sheet and Tube Co., Indiana Harbor, Ind.

F. C. McGOUGH

Δ THE principal subject of this paper is the world's largest rotary hearth furnace, rated at 100 tons per hour. Although the use of this type furnace for seamless tube mill operations has been long established, the combination of high tonnage and consequent fast cycle had not. The distribution of fuel was also a matter of concern in view of variations in billet sizes and lengths. Special features and equipment were necessary to provide a highly automatic operation.

Also briefly described are the mill's reheating and normalizing furnaces.

"ELECTRIC ARC FURNACE ANALYSIS VIA PHOTOGRAPHY"

by J. A. BROSOVIC, Senior Project Engineer, Electrical Laboratory, Republic Steel Corp., Cleveland, Ohio

J. A. BROSOVIC

Δ ELECTRIC arc furnace operations have experienced an intensive growth period during the past few years. Simultaneous with this growth, the furnace operating and maintenance problems, particularly those involving refractory performance, have become more serious and costly. One of the most serious of these problems frequently encountered in the operation of high powered arc furnaces is that of localized refractory burnout in areas of the lining located above the slag line. This phenomena is more commonly referred to as refractory lining "hot spots."

This paper covers the co-ordinated approach used by production, maintenance and laboratory personnel to isolate the cause of this problem and to devise a preventive maintenance technique capable of reducing its ill effects to a tolerable level. Normal and high-speed photography, along with mobile laboratory instrumentation, are described as the supplementary tools used to solve the problem. A simplified and mobile version of the laboratory instrumentation is suggested as a preventive maintenance tool for future control of the hot spot problem.

"VACUUM POURING FOR LARGE FORGING PRODUCTION"

by ELLIOTT A. REID, Assistant Chief Metallurgist, Bethlehem Steel Co., Bethlehem, Pa.

E. A. REID

△ THE adaptation of vacuum techniques to the needs of the heavy forging industry has been accomplished through use of the vacuum pouring process. In this process, a large quantity of molten steel, melted in conventional furnaces, is poured into a mold which is set up in a large vacuum tank, to produce the extremely large ingots needed for heavy forging manufacture. While being poured through the vacuum, the steel is relieved of much of the dissolved gases present and it is also protected from oxidation during the pouring operation.

The reduction of hydrogen content and the protection from oxidation result in important improvements to the quality of the product.

A development unit of 7-ton capacity and two 250-ton production units have been installed and are in operation at the Bethlehem plant. Design and construction of these units and their steam jet evactor pumps include many unique features.

Development of practices on the 7-ton unit while the 250-ton units were being completed made it possible to go into immediate production on the first 250-ton unit. A large number of ingots up to 120-in. diam. and 500,000-lb weight have been successfully produced and have proved the great value of the process.

The advantages of the process are not obtained without considerable expense for equipment and operation. Also the hazard of loss of ingot and equipment are increased. However, the improvement in quality of product more than justifies the added cost when critical applications of the product are involved.

"NUCLEAR ENERGY APPLICATIONS TO STEEL PLANT OPERATIONS"

by PATRICK J. SELAK, Manager, Nuclear Engineering Development, and RUDOLPH TIETIG, JR., Principal Engineer, Steel Plants Div., Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.

P. J. SELAK

△ THE authors describe various applications of radioisotopes in an integrated steel operation. Also discussed briefly is the use of nuclear energy as a source of process heat in support of raw material processing and steelmaking operations in areas of high fossil fuel costs.

Applications described include radiography, gaging and the use of radiotracers. The operations covered include the preparation

R. TIETIG, JR.

of raw materials, the production of coke and by-products, the blast furnace, production of steel ingots, rolling and finishing, inspection and quality control. Specific examples are given.

There is also some discussion of the health and safety problems involved and the related problems associated with the possible contamination of steel products.

"E. O. T. CRANE RUNWAY RAIL INSTALLATIONS"

by W. J. TUNNY, Superintendent, Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

W. J. TUNNY

△ PROBABLY, few things have created so many controversies in the mechanical as well as in the chemical and metallurgical fields as have rail designs and methods of installation. However, it is not the intent of this paper to produce solutions to all of the factors involved in poor crane rail performance, but to offer for future study, test and analysis, some of the major ills, which have been confronting the various groups of crane maintenance people responsible for its best performance.

Two major problems are encountered by those who must either design a crane runway or maintain one. First is to secure a rail that will have a long life under heavy loads, thus extending the cycle of costly and difficult replacement. Second, is to install the runway rails in such a manner that abuse to the crane, runway supports, and the rail itself will be minimized, thereby eliminating excessive maintenance.

Chemical and metallurgical processes used in the manufacture of wheels and rails have varied considerably in the past and probably will continue to change in the future because it is always necessary to search for better performance, longer life of material and less wear of these parts. There must be economical balance achieved between the wear of wheels and that of the rails so that the cost of prematurely changing one or the other, or even both will be minimized.

"DESIGN AND PERFORMANCE OF INDUSTRIAL LIGHTING SYSTEMS"

by DANIEL J. O'NEILL, Manager of Industrial Lighting, Holophane Co. Inc., New York, N. Y.

D. J. O'NEILL

△ A BRIEF review covering the six-year time between 1952 and 1958 shows lamps and reflectors presently available for use in steel mill lighting. Recent developments in incandescent, mercury vapor and fluorescent lamps as well as new types of reflectors are summarized.

References are made to illumination standards covering safety requirements, State Codes,

current industry practice, American Standard Practice, and proposed Illuminating Engineering Society recommendations.

Methods of making lighting layouts include point-by-point calculations and lumen or flux of light calculations with comparisons between the two design practices illustrated by means of five examples applied to a steel mill building. In these examples are shown typical photometric distribution curves and comparisons of calculated illumination values pointing out the limitations of lumen or flux of light method of predicting footcandle values.

Lighting test readings on six actual installations are reported together with comparisons of performance of lighting systems employing metal reflectors with fluorescent lamps and prismatic glass reflectors with 400 and 1000-w color corrected mercury vapor lamps. An interesting summary of measured maintenance factors is included as part of this extensive maintenance study.

Comparative cost examples are shown with comments regarding practical application of accurate cost figures especially when used with new developments in lamps and reflectors. In the absence of job performance information on new products, accurate predictions can be made to serve as a guide in the application of recently developed lamps and reflectors.

Suggestions are made for further job performance studies to cover an extended program encompassing a greater number of light sources and reflector types. If complete field test readings are reported and summarized, the industry can obtain valuable lighting application data for reference on new lighting system designs.

"WEIRTON NO. 2 SINTER PLANT"

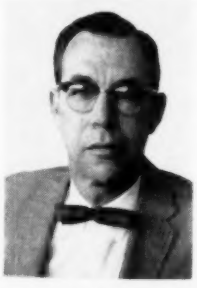
by G. W. WATSGN, Superintendent, Sinter Plants, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

Δ WEIRTON's No. 2 Sintering Plant which was recently put in operation is proving that the plant design is basically good and that the plant will reach the production goals set for it. Setting a new record in width, machine is 12 ft wide and 147 ft long, giving an active grate area of 1,764 sq ft. Plant is rated 6,000 tons per day.

"PROTECTING YOUR CABLE INVESTMENTS"

by CHARLES VAN HOY, Rubber Power Cable Engineer, Anaconda Wire & Cable Co., Marion, Ind.

Δ INDUSTRY in general, and the steel industry in particular, have a substantial investment in electric wire and cable. As this investment continues to grow, it seems worthwhile to give some thought to protecting this investment.



C. VAN HOY

Protection can be accomplished in five areas—namely, planning, procurement, storage, installation and maintenance.

Careful planning will make allowance for future expansion. Also care will be used in selecting the proper cable to do each particular job. Factors which must be considered are electrical requirements, economics, environment, temperature and mechanical protection.

Procurement should make use of technical services available from qualified suppliers. Also, this is the time to work out details on quantities, lengths, packaging and delivery schedules.

Proper storage of cable begins with inspection of the material as received. Temperature and protection from mechanical damage during storage deserve considerable attention. Overcrowding of the storage area and failure to use the oldest material first are common faults of many warehouses.

During installation, correct technique and adequate care should be used. Cable should never be installed against sharp objects and extremely hot locations should be avoided. Pulling tension, formation of kinks and mechanical damage need careful watching in order to avoid trouble.

A good maintenance program will include good splices and high quality repairs. Accurate records of installations, failures and corrective action taken form the basis of a sound cable maintenance program.

A fair share of attention to all of these matters will offer good protection for cable investment.

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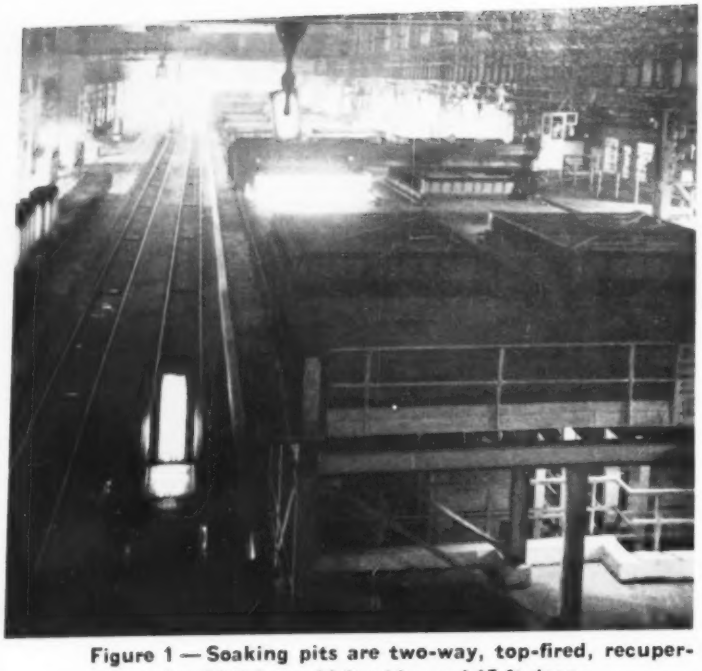


Figure 1 — Soaking pits are two-way, top-fired, recuperator units, 20 ft long, 14 ft wide, and 15 ft deep.

Figure 2 — Average ingot rolled on the 45-in. slabbing mill is 11 tons.

Operational Features of 45-In. Slab Mill and 80-In. Hot Strip Mill

by T. D. Clifford,
Division Superintendent,
Rolling Division,
United States Steel Corp.,
Fairless Hills, Pa.

THE 80-in. hot strip mill started operations in July, 1953 and the 45-in. slabbing mill began operations in September, 1953.

The department includes the following units:

1. Ingot stripping building.
2. Soaking pits.
3. 45-in. universal slabbing mill.
4. Slab conditioning and slab stocking area
5. 80-in. hot strip mill.

Except for the slab conditioning and stocking area, the units are in a straight line feeding one into the other. The conditioning and stocking area is parallel to the 80-in. mill, in back of the reheating furnaces.

This paper will start with the stripping building. All ingots poured in the open hearth pass through the stripper. The building is 288 ft long, 96 ft wide, and is located 172 ft south of the soaking pit building.

The work done in this building is the stripping of ingots, the cleaning of stools, buggies and the dipping of molds into the water tank.

The average number of ingots in a heat, as delivered from the open hearth, is approximately thirty-five. This means that the normal time to strip a heat will be a half hour or more, depending upon the type of ingot to be stripped and the number of cranes in service.

There are two methods used at this point to minimize the transit time of the ingots from the open hearth. First, depending upon the grade of steel and the metallurgical holding time, the heats are delivered from the open hearth to the stripper in halves. This means the first half of the heat can be pulled while the second half is still in the process of being poured. Remember this is not possible with all heats.

Second, any heat that is not delivered to the stripper building in halves from the open hearth will be split at the stripper and delivered to the soaking pits in halves. This procedure has been very beneficial in the controlling transit times. The quick delivery, at times, makes it necessary to water the top of the ingots before they

.... few mill setups incorporate as many advanced features as those built into the rolling mill division at the Fairless works of U.S. Steel....

Figure 3 — The 80-in. hot strip mill is in line with the slabbing mill which makes possible direct rolling of some products from the primary mill.

Mill at Fairless Works

can be stripped. A platform was erected, in the original installation, for this purpose.

One of the problems that still exists at the stripper is the lack of sufficient room to properly clean, slurry and straighten stools on the empty ingot cars. At the present time, the stools are being slurried, at the exit end of the soaking pit building, before they can be swept. Plans are to develop a location divorced from the stripper building which will allow proper maintenance of the open hearth stool cars.

After stripping, the ingots are moved directly into the soaking pit building which is 840 ft long and 113 ft wide.

The soaking pits are two-way, top-fired, recuperator furnaces. The centerline measurements of these pits are 20 ft long, 14 ft wide and 15 ft deep to the solid hearth. A 12-in. coke breeze bottom is used to protect the solid hearth. The two burners are located on the center lines of the end walls and fired diagonally over the top of the charged ingots. The furnace walls are veneered with a 13-in. quarried silica stone. The stone begins 21-in. above the hearth and is carried on seven courses of burned chrome magnesite bricks which are corbelled 4-in. towards the center of the furnace.

Each furnace has two recuperators located below and adjacent to the end wall waste gas ports. The recuperator chamber is 14 ft-9 in. by 6 ft-9 in. with a tube depth of 7 ft-9 in. and has an area of 20.8 sq ft for waste gas flow.

The details of the automatic controls are discussed in a paper titled "The Soaking Pits at Fairless" by Charles R. Wilt, Jr., 1955 Proceedings AISE, p. 255.

The soaking pits are entirely automatic with an emergency manual control. The automatic controls go so far as to shut the pit off when the cover is lifted and to re-light when the cover is replaced.

After changing the general heating practice today is to heat the pit to 2500 F and hold at this temperature a predetermined time. At this point, the pit resets itself to the specified metallurgical drawing temperature. This is done by means of a heat acceleration control which permits high induced heating in the beginning of the heating cycle and then adjusts itself to a lower drawing temperature.

One of the problems that confronted us at startup was maintaining an ingot temperature to reach a finishing temperature on the slab mill. The normal practice was to draw a pit completely before entering a second pit. Operating in this manner made it impossible for us to maintain the finishing temperature required. The slab mill was able to roll an ingot as fast, or faster, than one crane was able to draw an ingot. This resulted in the soaking pit cover never being replaced on the pit once the drawing had started. The answer to this was to draw only half a pit and then enter the second pit. This is now the established practice.

Another problem which confronted us was in determining the proper amount of oxygen to carry in the waste gases. The original setting was for a one-half of one per cent oxygen but this was not enough to give us a desirable type of scale. Extensive studies were made going as high as five per cent oxygen in the waste gases. This proved to be too costly. The decision, and the practice today, is to carry three per cent excess oxygen in the waste gases.

Each pit will have a fresh bottom of coke breeze every three days. The old bottom is swept through the four

trap doors placed in the bottom of the pit with the waste material falling into boxes placed underneath the trap doors. The boxes are then removed from underneath the pits, by means of the electric buggy, to an area outside the pit building which is provided with a mono-rail crane. This crane is used to dump the boxes into the railroad cinder car.

The soaking pits are serviced with two hot steel tracks for the handling of the incoming ingots from the stripper building. The hot steel tracks and the ingot buggy tracks run parallel to each other on the same side of the pits. The ingots, on drawing, are placed in one of two ingot buggies and delivered to the dumping tables. Having two buggies, there are two dumping tables, which, in turn, feed an ingot transfer table. This transfer table is then lined up with the front mill table to deliver the ingot to the slabbing mill.

The 45-in. slabbing mill and the 80-in. hot strip mill are located in a building 2208 ft long and 96 ft wide.

All ingots produced in the open hearth are broken down on this mill and are rolled butt first. The products rolled are slabs and slab shaped ingot breakdowns ranging from 5 to 11 in. thick and 20 to 75 in. wide. The slabs are for the 80-in. hot strip mill, and the ingot breakdowns are for the 40-in. blooming mill and the billet mill. At the present time, the 45-in. slabbing mill rolls 40 per cent of its product into breakdown blooms.

The average ingot weight rolled on the mill is 11 tons. The ingots rolled vary from 22 to 38 in. thick and from 32 to 80 in. wide.

After leaving the shears, the product can go in one of three ways.

1. It can be sent to the slab yard on a chain transfer table running at right angles to the mill line. It is on this chain transfer table that the product is identified by die stamping with an automatic stamper.
2. It can be sent directly to the 80-in. hot strip mill for further reduction without reheating.
3. It can be transferred by cable-drawn dogs to the 40-in. blooming mill where it receives further processing without reheating.

The crops, after shearing, are carried from the shear by a crop conveyor; dumped into a box; and the contents of the box dumped into a crop car. Underneath the mill, from the ingot dumping tables to the shear, is a flume to carry the scale and light debris into the scale pit. The heavier material falls onto the inclined gratings protecting the flume and is then removed by means of a small mono-rail hoist or a cable-drawn scoop.

The equipment also includes a four-sided hot scarfer located between the 45-in. mill and the shears.

The hot scarfing machine can be of great benefit to a rolling mill.

The procedures, as now established, are as follows:

The metallurgical observer is located in the roller's pulpit and is in the position to see the complete breakdown from ingot to slab. During this period, the observer determines whether the defects on the slab can be removed by the hot scarfer. If so, the slab is conditioned with the four-sided hot scarfer. If the defects are not removable by the hot scarfer, the slab is then sent to the conditioning yard unconditioned. One large defect could prevent the use of the hot scarfing machine.

It was also found that the hot scarfing machine would remove a light sponge or alligator type of surface but would cover up the heavy sponge or alligator type of surface. This was resolved by not hot scarfing this type of defect when it occurs in the heavy form.

Another development with the hot scarfer was the fact that not all grades of steel could be scarfed at the same speeds. The speeds will vary from 65 to 100 fpm.

The machine was originally designed to four side scarf but changes now make it possible to edge scarf without scarfing the top and bottom.

The details of the electrical features of the 45-in. slabbing mill and the 80-in. hot strip mill will not be discussed at this time. They are covered fully by the paper titled "Electrical Features of the Universal Slabbing and Hot Strip Finishing Mills at Fairless" by Warren Reid, 1955 Proceedings AISE p. 85.

The hot slab, on leaving the 45-in. mill table line and going to the slab stocking and conditioning area, is placed on a hot slab transfer car and is then taken to a cooling area preparatory for either conditioning or stocking.

The slab conditioning and stocking yard consists of two bays; each 528 ft long and 96 ft wide.

The bay containing the conditioning yard is the same wherein the hot steel is piled for cooling. The conditioning bed is 288 ft long by 40 ft wide serviced with two gantry cranes. This bay is also used for some stocking of steel for the 80-in. hot strip mill. The other bay is used, exclusively, for the stocking of material ahead of the reheat furnaces on the 80-in. hot strip mill.

The accumulated total of steel stocked in these two yards is approximately 30,000 tons. This 30,000 tons includes the steel in the cooling area.

As can be seen, the conditioning yard is fairly small and actually is not large enough to condition the entire slab product from the 45-in. mill. This is where the hot scarfing machine has been of substantial benefit.

The only place that cross piling is used in these two yards is in the cooling bay area, and the material is placed by using double "C" hooks suspended on a 360-degree turnaround assembly. All material in the stocking area is piled by grade and width. The reason for this is to minimize excessive handling of slabs when charging the reheating furnaces feeding the 80-in. hot strip mill.

The next and last unit in this department is the 80-in. hot strip mill. The equipment contained in this mill is similar to all other strip mills with the following exceptions. It has a vertical edging mill replacing the squeezer; and, instead of the usual three roughing mills, has four.

Television is used on the reheating furnaces. Each furnace has its own slab charger and all chargers are operated from a centrally located control pulpit. Television is used at this point for the spotting of the slabs charged in the end furnaces.

The furnaces are equipped with overhead metallic recuperators which deliver a 700 F preheat air.

The maximum slab charged in these furnaces is nine in. thick and 240 in. long.

The furnaces are rated at 135 tons per hour capacity and, as a result, curtail the production of the 80-in. hot strip mill. The big advantage of the strip mill being in line with the slab mill is that it permits direct rolling from the primary mill, bypassing the furnaces. This, on numerous occasions, has proved very beneficial to the ultimate production of the 80-in. hot strip mill.

The greatest difficulty experienced in direct rolling has been that of scheduling. If both mills, 45-in. and 80-in., could schedule more turns of operation it is felt that a good percentage of the product could be rolled direct into the strip mill. Again, the correct way to direct roll is to do it during furnace bottleneck operations. This means that approximately 40 to 50 per cent of the time direct rolling could prove beneficial.

The slab on leaving the furnaces enters a vertical edger, then the scalebreaker, then a broadside mill, followed by four universal roughers, a crop shear, another scalebreaker, then six finishing stands, and then into the coilers.

Material rolled on this mill is from 0.048 gage to 0.250 gage, from 24 to 73 in. wide and includes all grades required for sheet and tin processing except stainless and silicon steels. An x-ray gage and a width gage are used as a means of control.

The product rolled on this mill is coiled by three rotating mandrel coilers—550 lb per in. width, 2500 fpm (mandrel diameter 28 in.). This product is then transferred to the raw coil storage department for further processing or shipment. The coil conveyor is the chain type which is in three sections; and, as stated previously, is 1057 ft long.

All coils are banded and identified after being placed on the conveyor.

The systems for roll cooling and descaling should be mentioned. The descaling system consists of three pumps, each with the following capacities: 1200 gpm; 1500 psi; 1500 hp.

Strip descaling is done at six different locations in the mill train. Water is supplied to this system direct from the river pumping station.

The roll cooling system has three pumps, each with a capacity of 2500 gpm at 200 psi and one pump at 5000 gpm at 200 psi.

Roll cooling heads are sectionalized for better shape control and water conservation. Water from the reheat furnaces is recirculated from a reservoir to supply this system.

The lubricating system is as follows:

System No. 1—backup roll, 11 stands, two 16,000-gal tanks.

System No. 2—pinion and screwdown, 12 two 12,000-gal tanks.

System Noi 3—gear reduction drive, 11, one 16,000-gal.

System No. 4—vertical edger, one 4000-gal tank.

System No. 5—main motors and generators, one 2500-gal tank.

A centralized grease system.

Discussion

PRESENTED BY

GORDON C. CAMPBELL,
Industrial Engineer, Strip Mill,
Alan Wood Steel Co., Conshohocken, Pa.

T. D. CLIFFORD, Division Superintendent,
Rolling Division, United States Steel Corp.,
Fairless Hills, Pa.

C. E. PRITCHARD, Superintendent of Mills,
Alan Wood Steel Co., Conshohocken, Pa.

M. B. ANTRIM, Assistant Manager,
Maintenance and Construction Div.,
Lukens Steel Co., Coatesville, Pa.

H. H. ANGEL, Electrical Engineer,
Construction Engineering Dept.,
Bethlehem Steel Co., Bethlehem, Pa.

Gordon C. Campbell: What is the required finishing temperature on your 45-in. slabbing mill?

T. D. Clifford: The 45-in. slab mill has an aim of 2075 F for finishing temperature. The minimum acceptable temperature is 2050 F.

C. E. Pritchard: Mr. Clifford, your comments pertaining to the ingot buggy operator pacing the 45-in. mill brings up the question as to whether or not he has ready access to proper sighting of the mill operation at all times. If not do you use other devices such as a television camera as an aid to ascertain whether or not the mill is kept full at all available times?

T. D. Clifford: The ingot buggy operator has full vision of both the soaking pits and the entry side of the 45-in. slabbing mill. No devices, such as a television camera, are used to aid vision. However, the operator has two intercommunication systems to aid in controlling the flow of steel to the mill. One system connects the buggy pulpit with the soaking pit recorder and the 45-in. mill pulpits, the other system connects the buggy pulpit with the cover cranemen and overhead soaking pit cranemen.

M. B. Antrim: It was mentioned in your paper that the ingot buggy operator paces this mill. Since the buggy operators position is usually regarded as being one of the lower rated jobs, what effect does this have on the normal working relationships among the rolling crew?

T. D. Clifford: The 45-in. roller is responsible for the proper pacing of the mill. The roller relies on the ingot buggy operator for the proper spacing of the ingots and only corrects him when poor judgment is being used. The ingot buggy operator is part of the mill crew and shares in their incentive.

H. H. Angel: I do not recall, Mr. Clifford, that you mentioned anything in reference to the crane operators controlling the soaking pit covers from the cranes. Now, do they have such control? If not, do you contemplate installing such equipment in the future?

T. D. Clifford: The overhead cranemen do not control the soaking pit covers from the cranes. The possibility was investigated but it was decided to be impracticable with the present equipment.

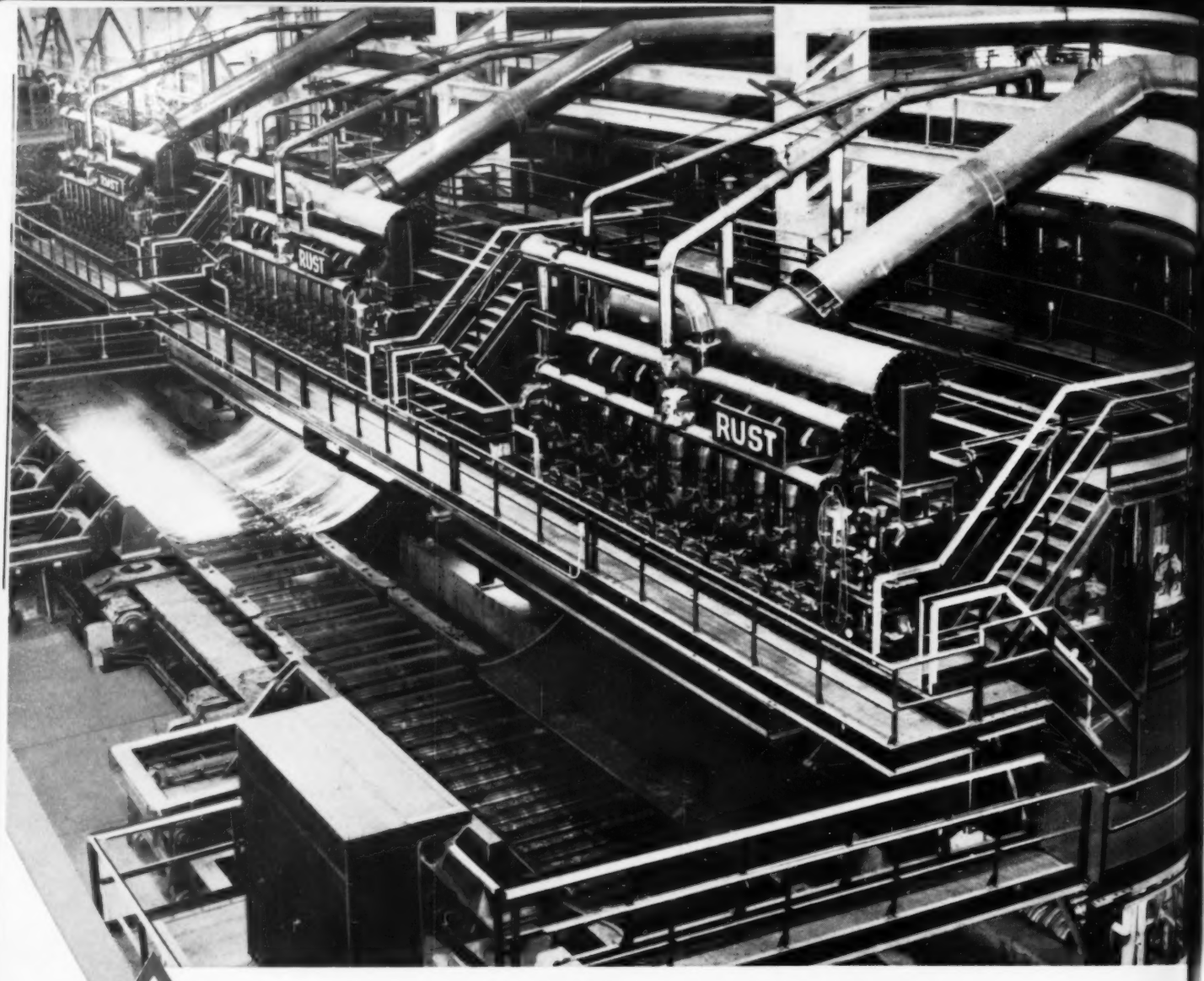
C. E. Pritchard: On the 80-in. mill runout, you elaborated a bit on the water cooling systems for roll contour control and also displacing and control of heat through the mill. How about the runout-table area, what method of water application is applied to the strip to control the temperature during the coiling cycle?

T. D. Clifford: The runout table is 400 ft long and has strip cooling sprays for 280 ft.

There are 42 top sprays, separated into six banks. Top sprays are approximately 6 ft apart.

Bottom sprays are positioned between every other table roll and controlled in banks with overhead sprays.

Feed line water pressure is 65 psi. Vee set nozzles are used in all headers. ▲



Triple-Fired Continuous Slab Reheating Furnaces

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THREE completely AUTOMATIC gas-fired RUST FURNACES, designed and constructed for Kaiser Steel Corporation's Fontana Works. Each furnace is designed to heat cold slabs to rolling temperatures at a rate of 150 tons per hour. Internal dimensions of furnaces: 24′ wide x 100′ long. Metallic recuperators minimize fuel consumption. This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Consult us about your furnace requirements – melting, reheating or heat treating.

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IS ONE JOB WITH A
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One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

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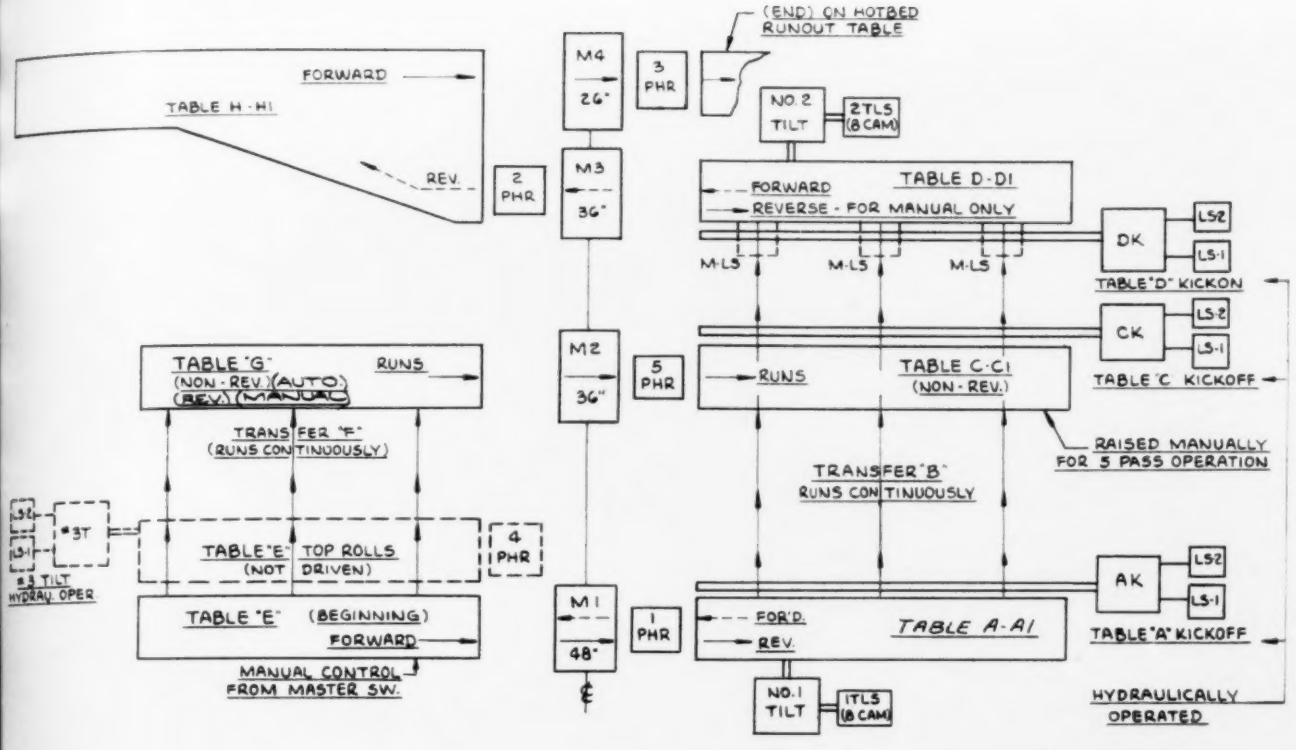


PATH OF BAR FOR 3 PASS AUTOMATIC OPERATION:—
FROM TABLE "E" THRU "M1" LOWER ROLLS, 1 PHR LIGHT BEAM ONTO TABLE "A-AI" WHERE IT STOPS. BAR IS KICKED OFF BY "AK" ONTO TRANSFER "B" AND CARRIED TO "M-LS" & THEN KICKED ON TABLE "D-DI" WHICH TILTS UP & THEN PASSES THE BAR THRU "M3" UPPER ROLLS, 2 PHR LIGHT BEAM ONTO TABLE "H-HI". TABLE "H-HI" REVERSES AUTOMATICALLY PASSING BAR THRU "M 4", 3PHR LIGHT BEAM ONTO "HOT BED RUNOUT TABLE."

PATH OF BAR FOR 5 PASS AUTOMATIC OPERATION:—
FROM TABLE "E" THRU "M1" LOWER ROLLS, 1 PHR LIGHT BEAM ONTO TABLE "A-AI" WHERE IT STOPS. TABLE "A-AI" IS RAISED BY NO. 1 TILT AND THEN STARTED FORWARD. BAR PASSES THRU "M1" UPPER ROLLS, 4 PHR LIGHT BEAM ONTO TABLE "E" TOP ROLLS AND THEN IS TILTED ONTO TRANSFER "F" BY NO. 3 TILT. TRANSFER "F" DEPOSITS BAR ON RUNNING TABLE "G", FROM WHERE IT PASSES THRU "M2" ROLLS, 5PHR LIGHT BEAM ONTO TABLE "C-C1" WHERE IT STOPS. BAR IS THEN KICKED OFF ONTO TRANSFER "B" BY "CK" FROM WHERE THE PATH OF THE BAR IS SAME AS FOR 3 PASS OPERATION.

Figure 1—Schematic diagram shows operation of No. 3 mill.

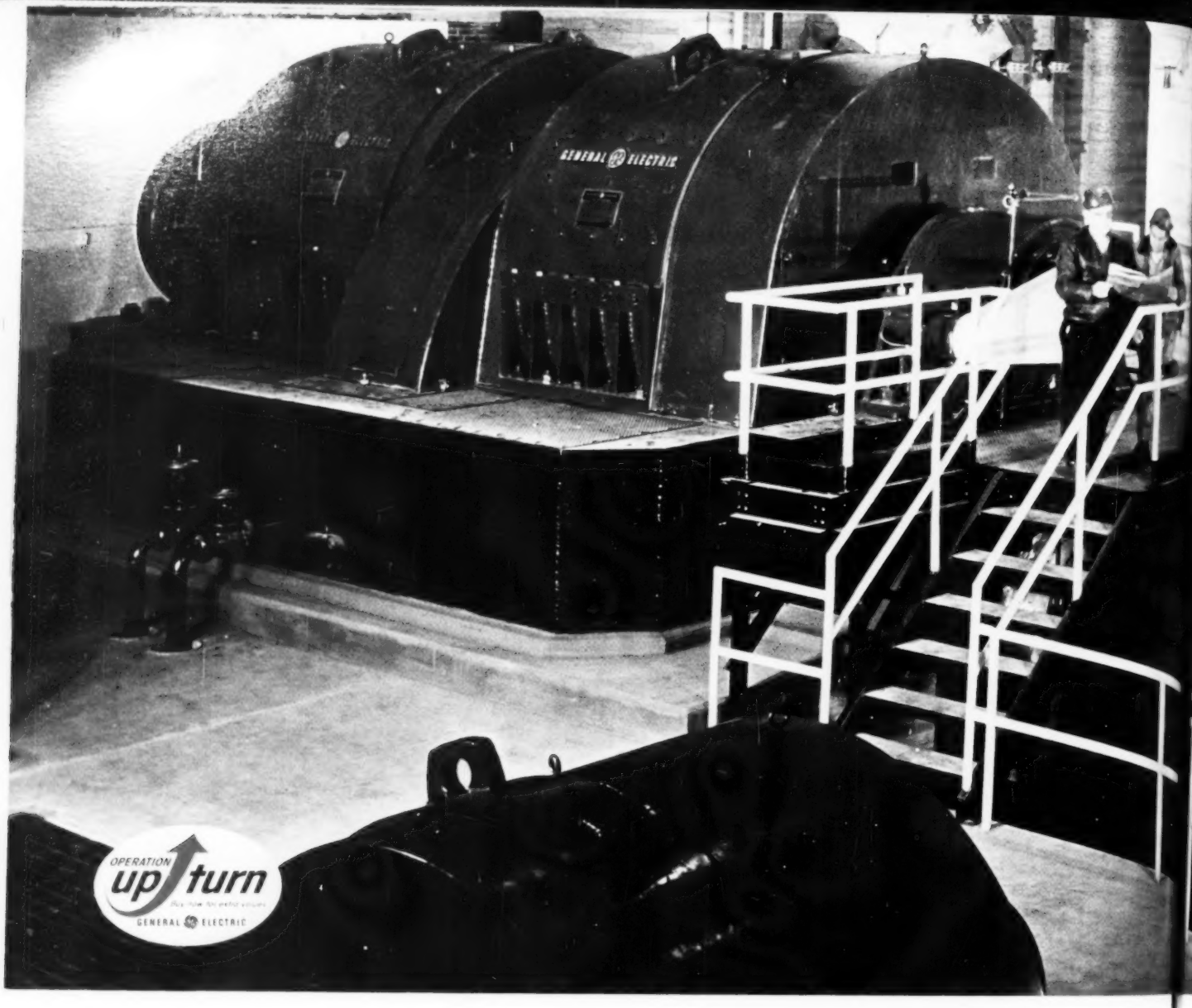
Bar Mill Operates Automatically

by C. A. BILLANTE, Electric Controller & Manufacturing Co., Division of the Square D Co.
and G. LAMBERT, Connors Steel Division, H. K. Porter Co.

AT the Connors Steel Division of H. K. Porter Co. in Birmingham, Ala., a 4-stand bar mill with two tilt tables has performed successfully under automatic control since 1956. Bars or slit rails are heated and rolled into various bar-type end-products.

The operator initiates the first table for entering the bar or railstock into the first mill stand. Thereafter the operation is completely automatic. Tables, transfer drives, tilting tables and kick-off drives are started, stopped and reversed under limit switch control. Infrared radiation detection type limit switches signal the passing of the tail end of a rolled section and cause preceding drives to stop and subsequent movements to start up. The operator may operate manually at any point in the cycle and return to automatic operation as soon as the need for manual manipulation has passed.

Complete electrical control equipment was built by the EC&M Division of Square D Co. The automatic control system was developed by EC&M, working with the engineering personnel of Connors Steel. Rust Engineering and Canterbury Electric Co. did the installation. Reduced costs and increased output are being obtained. ▲



GENERAL ELECTRIC ANNOUNCES . . .

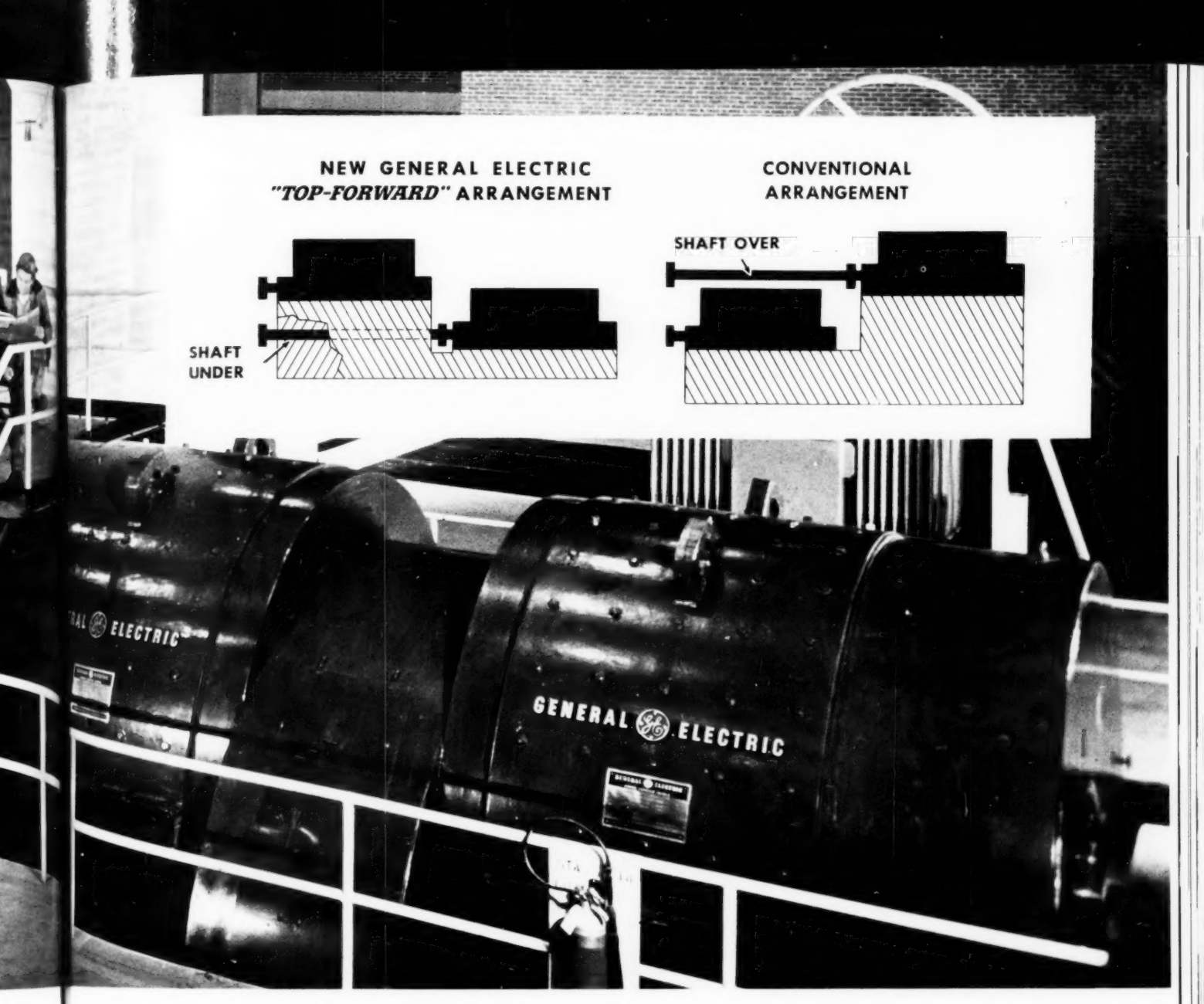
Revolutionary Redesign for M

With "ease of maintenance" as the major criterion, General Electric engineers recently completed the dramatic redesign of large direct-current motors for metal rolling mill applications.

The result of a complete re-analysis of industry drive requirements, the new standard G-E metal rolling mill motors are forced ventilated, and are furnished with enclosing covers and Class B insulation throughout.

REVOLUTIONARY *"TOP-FORWARD"* twin-drive arrangement exemplifies G.E.'s emphasis on "ease of maintenance." The top motor is located nearest the mill with the rear motor shaft running underneath. This unique arrangement makes both motors more accessible for fast, easy maintenance, and substantially reduces installation and construction costs.

Other extra-value features available now include quick-removable air shields, which eliminate



for Metal Rolling Mill Motors

time-consuming unbolting; constant-pressure brush holders, requiring no brush pressure adjustment; use of self-locking nuts and bolts to fasten internal components; and built-in inspection light, utility outlet, plus many other features designed to make maintenance faster, easier.

A COLORFUL NEW BROCHURE, GEA-6812, "D-c Drives for Metal Rolling Mills," describes this revolutionary new design. Contact your nearest General Electric Apparatus Sales Office, or write for it today. General Electric Company, Section 772-6, Schenectady 5, New York.

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GENERAL ELECTRIC

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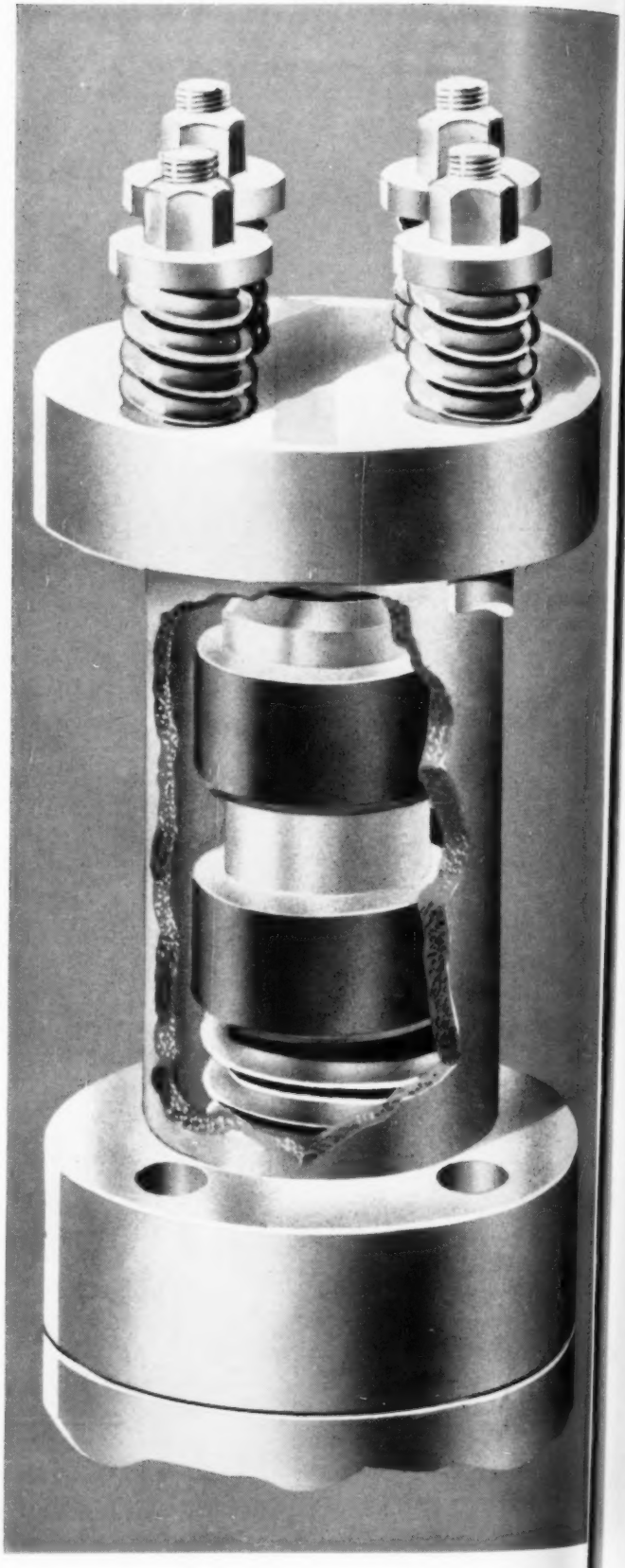
by bringing you lower precipitator maintenance and operating costs with

K-30*

bonded pistons on pneumatic vibrators



By eliminating the need for lubrication of the rapping mechanism in electrostatic precipitators, Koppers saves you many operational man-hours and maintenance costs.

This lubrication-free operation results from bonding a new wear-resistant material to vibrator piston surfaces. This special self-lubricating compound, identified by Koppers as "K-30," is composed of Teflon† and other wear-resistant materials that together provide a self-lubricated surface.

Most rapping mechanisms demand regular maintenance to be trouble-free, but "K-30" eliminates this need and provides more reliable operation.

Koppers research, backed by many years of experience in the electrostatic precipitation field will help you find the answer to your gas cleaning problems. Check with Koppers to learn how "K-30" can develop top efficiency in present or planned precipitator installations. For more information, write: KOPPERS COMPANY, INC., 8309 Scott Street, Baltimore 3, Maryland.

*Koppers Trademark

†E. I. duPont de Nemours & Company, Inc. trademark for tetrafluoroethylene resin

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Mill Drive Motor Line Incorporates Advanced Features

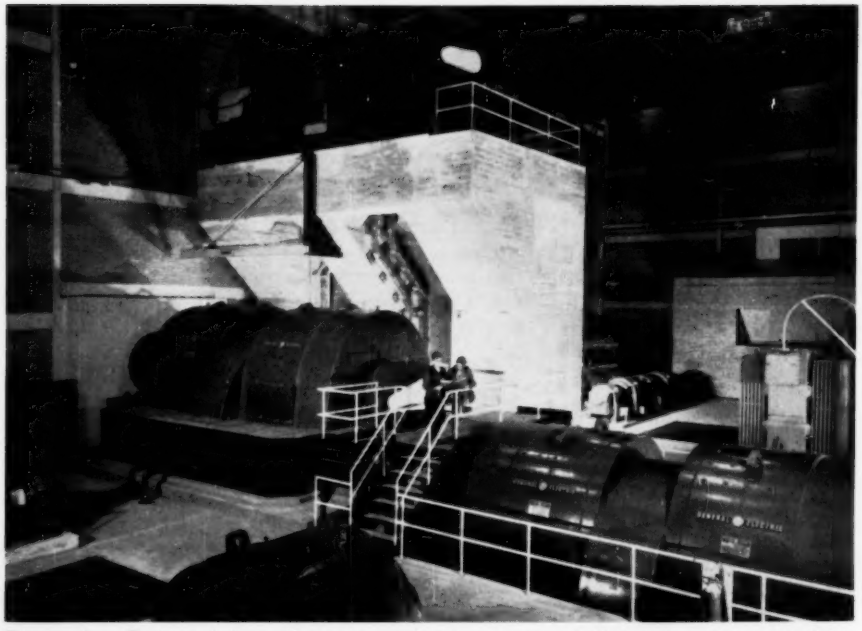


Figure 1 — Reduced downtime for maintenance is predicted for these double-armature 12,000-hp, twin-drive motors in operation at a large capacity slabbing mill in the eastern United States.

A NEW standard metal-rolling-mill motor line, designed to meet the requirements of modern mill practice, was recently announced by the General Electric Co.'s Large Motor & Generator Department. The new standard motor line resulted from a complete re-design, during the past four years, based upon a thorough review of modern mill drive requirements.

The standard motor is in accordance with NEMA Standards, both 40 and 50 C ratings is forced ventilated and is furnished with Class B insulation throughout. Quick removable covers provide enclosure on both ends. The re-design, which includes both electrical and mechanical elements of the motor, incorporates a number of innovations for greater ease of maintenance as well as increased dependability.

Some 40 special design, performance and maintenance improvements have been incorporated in the main drive motors.

Since one hour of mill outage results in considerable loss of revenue to a steel company, adequate maintenance of the vital parts of the machine is imperative to minimize unscheduled outages. These designs and developments have been made to significantly reduce the time required for good maintenance.

For instance, the new arrangement of twin-drive motors for reversing hot mills is an example of product re-design which drastically cuts maintenance. Previously the twin-drive motors have had the upper motor away from the mill, with an extension shaft over the lower motor. For maintenance purposes,

Figure 2 — This 9-ft diam rotor for 7000-hp, twin-drive is force ventilated in both 40 and 50 C ratings, is furnished with Class B insulation throughout, and features improved riser construction.

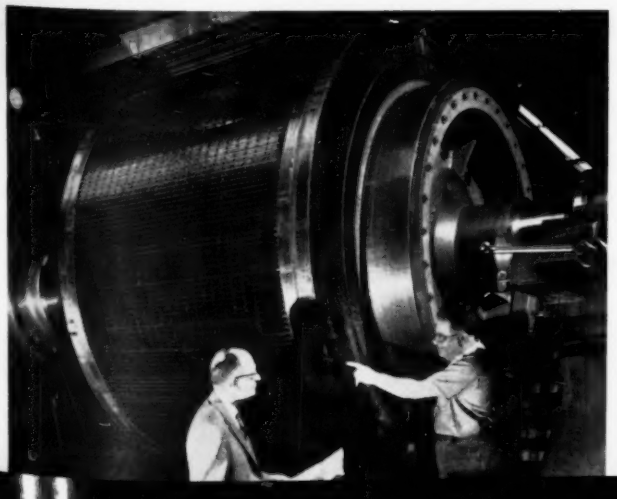


Figure 3 — Forged-flange construction of the coupling for both the rotor and extension shafts of the new advanced main drive motors for metal-rolling-mills will provide increased strength to absorb shock loads.

the extension shaft had to be removed for access to the lower motor, and one of the two thrust bearings was difficult to reach.

The new standard GE twin-drive has the upper motor located near the mill, with the lower motor set back. The extension shaft, located beneath the upper motor, can be removed toward the mill, and both thrust bearings are equally accessible. This new "Top-Forward" arrangement has already received wide customer acceptance, having been applied to eleven new twin-drives in the past two years.

The use of forged-flange couplings, with their smaller diameters, has made the new arrangement practical. The coupling which is forged as an integral part of the shaft, is inherently stronger as a homogeneous structure and eliminates the stress concentration due to a keyway.

Some of the outstanding features included in the new standard motor line are:

1. Quick removable covers over both ends provide almost immediate access to the motors. All cover bolts have been eliminated so that the cover can be removed in the time it takes to attach the crane cable to the lifting eyes.

2. The rotor coil insulation system consists of the field-proven mica mat insulation with glass tape slot armor. To protect these basic insulation materials from the ravages of foreign matter, the system has been improved by impregnating the insulation with a newly developed solventless thermo-setting resin.

Figure 4 — Important features of the new riser construction are epoxy resin filler, pre-curved risers, and glass-cord ties, all of which give increased shock strength to risers and result in significant increased life under severe duty.

3. The stator insulation system has been improved by the use of high-temperature-resisting resins. After the coils have been assembled in the machine, the entire windings are immersed several times in a high quality varnish of a color selected to reveal dirt that accumulates during operation in service. This insulating varnish protects the finished windings from moisture and dirt as proved by field tests. This color system should assist in determining the proper time to clean the machine.

4. Constant-pressure brush-holders are standard for both non-reversing and reversing motors. These holders maintain correct brush pressure at all times, and the need to adjust brush pressure is eliminated. The brushes and brush holders are designed to visually indicate the proper time for replacement.

5. All steel self-locking nuts and bolts are utilized in the interior of the motor to fasten components which might become loosened through vibration.

6. Additional easy maintenance features are built into the motors to assist inspection personnel. Inspection lights and utility outlets are conveniently located inside the motor. This provides a power source for hand tools, eliminating the bother of obtaining temporary lighting and power, thus encouraging effective routine inspection and maintenance. The painting of the complete interior of the machine is co-ordinated to reflect the maximum amount of light, for easy inspection, and to reveal any accumulation of dirt as a signal for cleaning.

7. Integral ventilation of mill motors is available as a standard modification. An integral ventilation system, including blowers, filters and coolers, can save on installed cost, and results in reduced maintenance costs.

A number of these advanced features have already been installed on various metal-rolling mill drives shipped from General Electric's Large Motor and Generator Department, and main drives incorporating all of these new developments are expected to be in operation next year. ▲

How to measure

Now is the time to take a long, hard look

A continuous furnace is more than just a brick-lined structure built to heat a material; it is a processing tool.

Like all processing tools, it must be evaluated on an overall basis. Fuel consumption and efficiency may be completely outweighed by many more-important economic factors centering around your workpiece, your total production program, and your work force.

Your evaluation may well prove that an investment now in Selas continuous heat processing will bring immediate returns in reduced costs and improved product quality.

To help you take this long, hard look at your heat processing equipment or requirements, Selas offers these 15 evaluation factors:

- **Material saving**
- **Product quality**
- **Floor space**
- **Product value**
- **Work in process**
- **Labor requirements**
- **Process coordination**
- **Maintenance**
- **Material handling**
- **Automatic operation**
- **Temperature control**
- **Production requirements**
- **Equipment flexibility**
- **Fuel efficiency**
- **Human element**

The factual report on the facing page tells how a steel mill took this long, hard look at its forge shop operations. Every evaluation factor proved significant: several represented important savings.

See Selas Heating in Action at the Iron and Steel Exposition, Booth 91

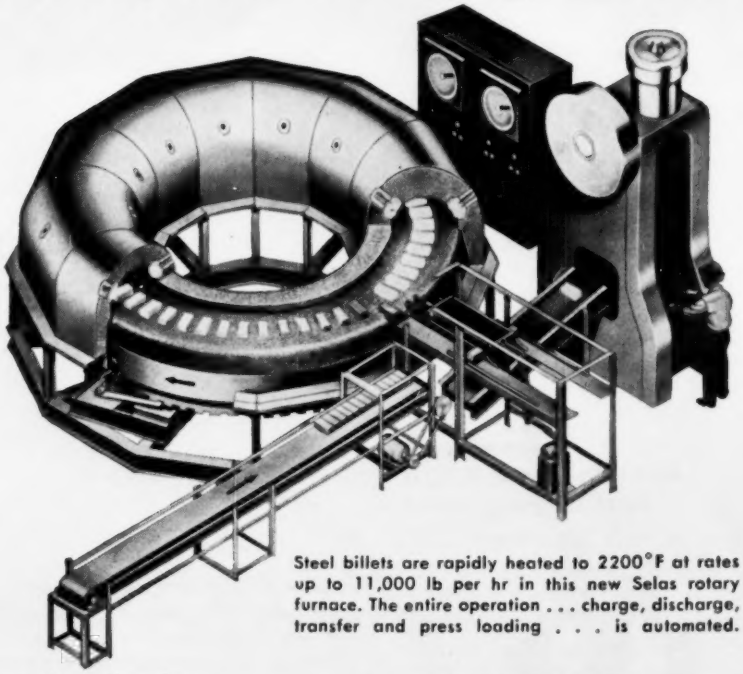
the real cost of continuous heat processing

. . . here's how one SELAS installation stands up under that "long, hard look!"

SELAS fast-heating techniques for hot working operations are proving that steel heated rapidly—with no soaking necessary—exhibits improved metal flow beyond that of steel heated slowly and soaked.

This improved forgeability reduces power requirements at usual forging temperatures, or, for a given amount of applied power, permits an increase in degree of deformation; enables working the steel at lower temperatures with no increase in applied work or die wear.

Heating steel billets for forming of special aviation parts and other close-tolerance forgings in a large eastern steel mill, this compact rotary hearth furnace secured important savings in cost, space and labor.



Steel billets are rapidly heated to 2200°F at rates up to 11,000 lb per hr in this new Selas rotary furnace. The entire operation . . . charge, discharge, transfer and press loading . . . is automated.

Material Saving

Scale produced during the 11-min heating cycle of a 4-in. square billet, is 0.004 in. thick. This loss in weight is less than 0.25%, compared with 6-8 times that amount when heating to forging temperature in conventional furnaces. At only 1% saving, $1,000 per 40-turn month is recovered—without considering effect upon product quality, machining cost, die wear and similar side effects of excessive scale.

Product Quality

Short cycle heating, to 2250°F in only 11 min produces finer grain, greater forgeability at temperature, improved material flow in the press, and, therefore, a tougher, stronger forging.

Floor Space

The characteristic compactness of Selas high capacity equipment . . . with heat directed into the workpiece, not the work area . . . results in a 60% saving in floor space. Pitch diameter of this 11,000 lb per hr furnace is only 13¾ ft. The smallest conventional furnace offered for this duty had a pitch diameter of 21 ft covering 2½ times as much area as this Selas unit.

Product Value

In slightly more than one 40-turn month, the product value of the billets processed equals the cost of the furnace and mechanical equipment.

Work in Process

Less than 1 ton of material is in the furnace at one time, as compared with 11 tons under a conventional 2-hr heating program.

Labor Requirements

Automatic handling of heated billets makes press operation a one-man job—saves $1300 per month.

Process Coordination

Fitted into the processing line, the furnace forms one important unit, with the press, trimmer and delivery conveyor completing the production picture. The custom-built rotary furnace was shipped from Selas, assembled in sections, and installed with minimum interference to the customer's production operations.

Maintenance

Simple, reliable operating and control equipment, rugged construction, and absence of special atmosphere equipment, simplify routine maintenance. Sectionalized construction will make eventual relining quick and economical. Furthermore, a Selas factory-based service engineer supervised installation and start-up, instructed personnel in operation and maintenance, and is available on call.

Material Handling

Completely automatic for billets weighing up to 55 lb; manual handling is used for heavier billets.

Automatic Operation

Entire heating cycle is automatically controlled, requires only intermittent loading of charge table, occasional check of temperature instruments.

Temperature Control

Billets are delivered metallurgically uniform throughout each billet and from billet to billet.

Production Requirements

The furnace supplies sufficient material for normal press operation with some reserve capacity.

Equipment Flexibility

The furnace heats billets from 3¼ in. square x 5.1 in. long, to 7½ in. square x 24 in. long. Steels handled include types 1030, 4620, 4815 and 8720.

Fuel Efficiency

Fuel cost, without recuperation, averages only 3% of raw material value.

Human Element

The automatic control eliminates variations due to the human element. Also, the furnace and press cycles are synchronized to enable delivery of a properly heated billet to the press immediately as forging of the preceding billet is concluded (in effect, pacing the press operator).

* * *

For case histories covering other steel mill heat processing operations, as well as heat treating, heating for hot working and brazing, send for reprint "An Economic Appraisal of Continuous Heat Processing." Address Dept. 49

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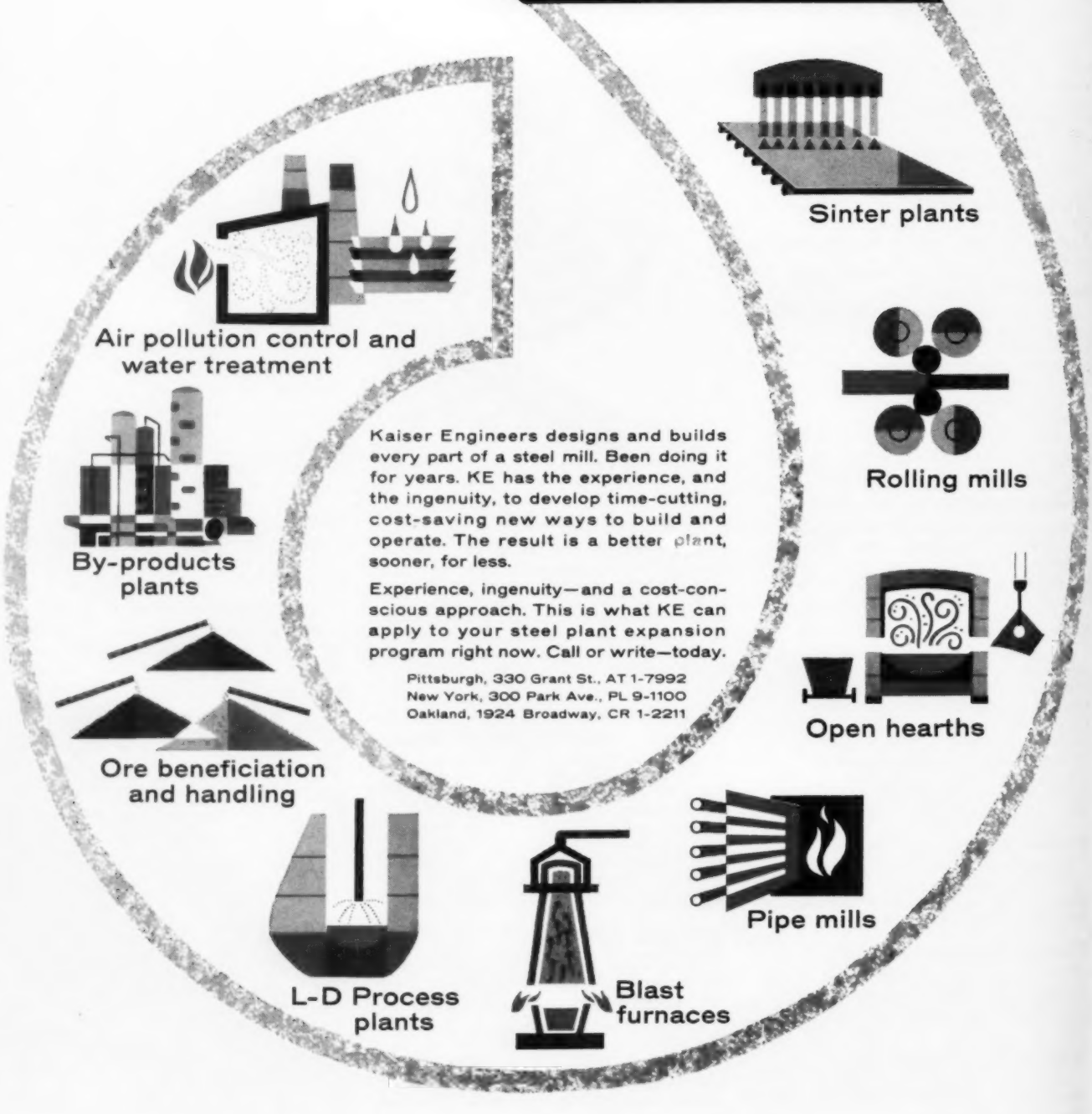

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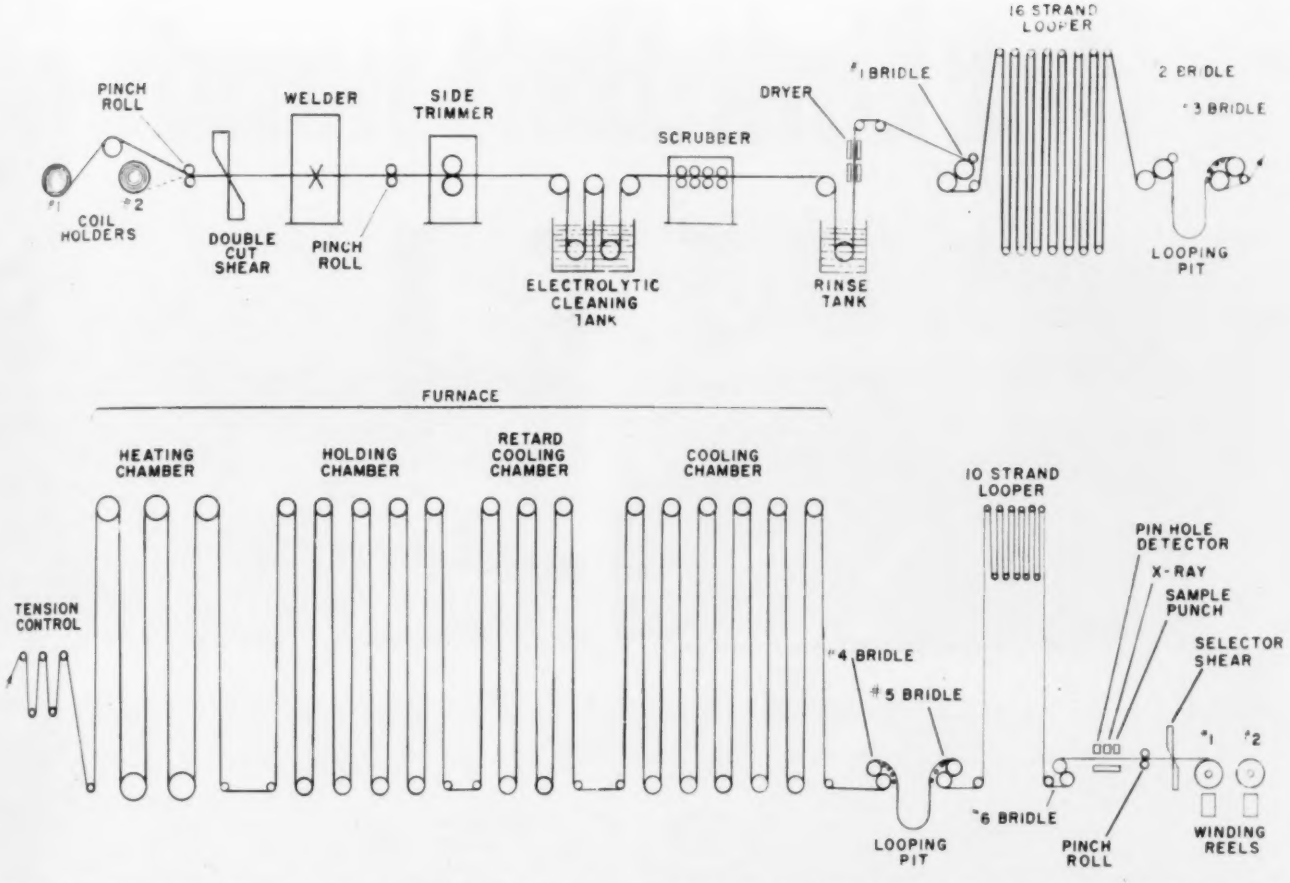


Figure 1 — Schematic diagram shows new continuous annealing line to be installed in the Aliquippa Works of the Jones & Laughlin Steel Corp.

J & L to Install New Continuous Annealing Line at Aliquippa

JONES & Laughlin Steel Corp. announced plans for the installation of a modern high-speed continuous annealing line, one of the latest developments in the production of quality tin plate, at its Aliquippa, Pa., Works.

The new line, which will cost in excess of $7,500,000 will be engineered to operate at speeds up to 2,000 fpm in a combination cleaning-annealing operation. This operation imparts to the strip steel an extremely uniform degree of physical properties suitable for a wide variety of tin plate uses.

J&L's new line, on which construction is scheduled to begin in the near future, is the first of its type designed with co-ordinated mechanical and electrical drives throughout the equipment. This improvement will minimize variations in tension throughout the line during acceleration and deceleration, and provide greater uniformity of product as well as maximum utilization of equipment. It should be completed in 1959.

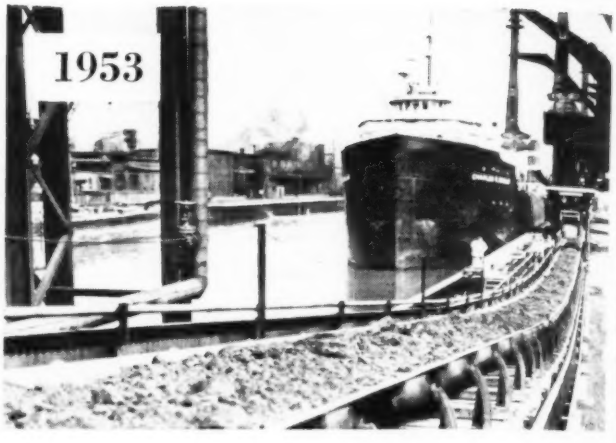
Some of the more important advantages of the new equipment include greater uniformity of product, use of fewer types and tempers, simplification of inventory, the possibility of lighter basic weight or gage, improved container strength where needed, and less annealing time which will result in a shorter tin mill production cycle.

The new line will handle coils of strip steel weighing up to 50,000 lb and up to 38½ in. in width. Its capacity, at top operating speed, will be 30 tons of tin plate per hour.

The new facilities will be installed in a building in the immediate vicinity of J&L's five-stand tandem cold reducing mill in the tin plate department.

In the operation of the line, coils from the five-stand tandem cold reducing mill are fed into the line, which will clean the strip, and then pass it through gas- and electrically-heated sections of a furnace. Here, the strip is raised to a carefully regulated temperature, then gradually reduced to atmospheric temperature. After annealing, coils are first temper rolled, and then electrolytically tin plated. ▲

3rd Link-Belt handling



1957

THIS MAIN DOCK BELT CONVEYOR is part of the newest of three materials handling systems Link-Belt has built for one of the largest steel companies in the country. It operates at 500 fpm and handles 6200 tons of iron ore per hour. Other equipment at these installations is shown on next page.

system for 1 steel maker

LINK-BELT conveyors serve blast furnace areas at 3 eastern mills—handle raw materials from unloading, in and out of storage, to mill

Though modern blast furnace burdening techniques have multiplied problems of storing and reclaiming bulk materials, Link-Belt conveyors are cutting handling costs for steel mills throughout the country. The systems shown here are typical. So successful was the first installation for this steel company, Link-Belt twice more was called on to furnish complete facilities.

Link-Belt can bring similar efficiency—the same safe, high-capacity, low-cost handling—to every step of steel production in your plant. Link-Belt conveying systems are designed to make the most of existing space, adjust to increased capacities, fit into new processes. They simplify storage and reclaiming of raw materials . . . speed up production procedures . . . permit fast, easy intraplant movement of materials and products.

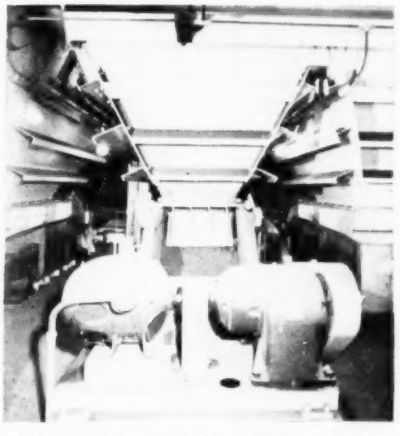
When relied upon for one-source service, Link-Belt accepts full responsibility for placing a system in successful operation . . . will work with your consultants and engineers to provide the best in modern handling of raw materials and steel in every form. For details, contact your nearest Link-Belt office.

BELT CONVEYOR — 60-in. wide with 2000-ft. centers — is reversible to permit reclaiming as well as stockpiling of iron ore. It can handle 6200 tph when stocking out — reclaiming capacity is 2500 tph.

BELT CONVEYOR STACKER, typical of the unit furnished each installation, here delivers coal on the right and with boom positioned on the left stockpiles iron ore or limestone within range of bridge.

REVERSIBLE TRANSFER BELT CONVEYOR handles 6200 tph. Located in junction house, it can deliver ore either to conveyor going to screen house or to stocking out conveyor.

SHUTTLE BELT CONVEYORS deliver iron ore to six 1500-ton capacity blending and surge bins in screen house. These two conveyors are reversible. Each serves three bins and assists in blending ores.



MANGANESE APRON FEEDERS under storage bins in screen house operate at 35 fpm and handle 500 tph. Each is powered by a 15-hp motor connected by flexible coupling to a Link-Belt drive.

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A Checklist for Maintenance of INDUSTRIAL TRACK

UPKEEP of industrial railroad trackage is one of the most neglected phases of plant maintenance. Deterioration of trackage has three serious consequences. First, unsafe conditions may lead to injury of personnel and costly equipment damage through derailment or other serious accident. Second, haphazard repairs made on a day-to-day basis interrupt regular schedules and directly cause loss of production time. Third, continual neglect eventually necessitates major track repair at a cost in money, time and labor that could and should have been avoided by a sound maintenance program.

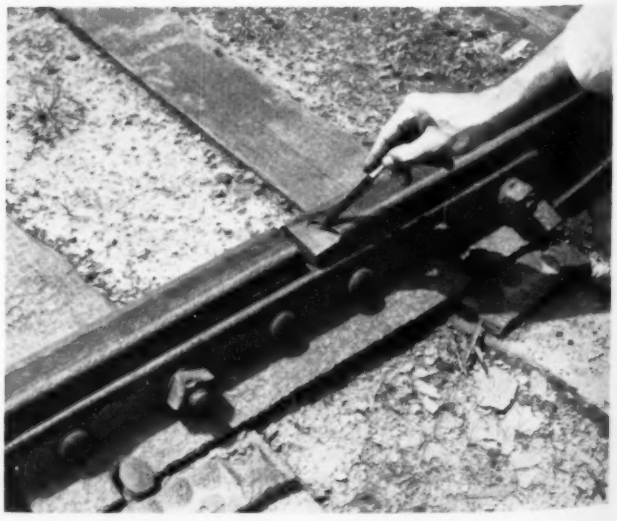
Properly organized and managed, a track maintenance program will help prevent accidents and will materially reduce the need for, and cost of, track repair and replacement. In most cases the general appearance of plant property will be improved considerably.

Crucial to any maintenance program is a regular inspection of track facilities to determine general condition and need for repair. A secondary but important purpose of the inspection should be to determine whether existing track layout and track equipment are adequate for the current volume of traffic. Ideally such an inspection should be made every three months.

The checklist given here includes all important points which should be covered on track inspection. It was prepared by rail and track specialists of the L. B. Foster Co., national supplier of new and relaying rail, as part of a "Track-Check Kit" which includes a 16-page instructional pamphlet on track maintenance procedures and a form to be used during track inspection to indicate work need and parts and supplies to be ordered. The kit may be obtained free by writing to L. B. Foster Co., P. O. Box 1647, Pittsburgh, Pa.

Figure 1 — Neglect of industrial railroad trackage will result in dangerous, unsightly conditions shown here. Lack of ballast and drainage have weakened and rotted ties. Many spikes are loose; some are missing. Weeds and caked mud clutter area.

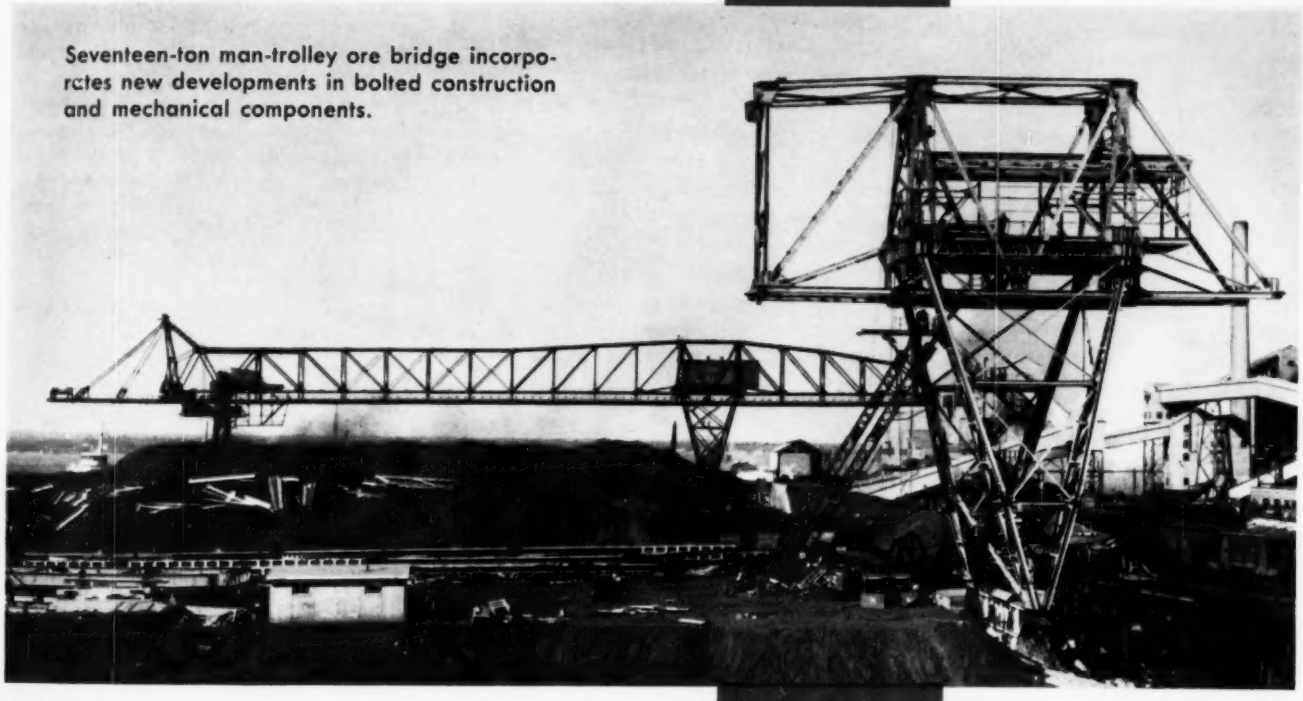
Figure 2 — Severe "end clipping" at rail end and excessive joint expansion are danger points in this rail joint. Tie plate is worn, and spike is loose. Bolts on rail joint should be alternated.



Under Construction . . .

5th Mead-Morrison Ore Bridge

for Major Canadian Steel Producer



Seventeen-ton man-trolley ore bridge incorporates new developments in bolted construction and mechanical components.

This new 17-ton Mead-Morrison direct ship unloading and stocking ore bridge features, in addition to the advanced Mead-Morrison construction that has been proved in the preceding four bridges, a number of exclusive Mead-Morrison developments. These include the use of high tensile steel bolts at all field connections for strength and economy of structural maintenance, extra safe hydraulic rail clamps, new hydraulic buffers, and a new type of man-trolley suspension.

This bridge joins a seventeen-ton bridge completed in 1952, a twelve-ton bridge built in 1942, and two twelve-ton bridges installed in 1931. All these bridges were designed, engineered and built by Mead-Morrison and have given complete satisfaction throughout their life.

If you have material handling problems, you can find your answer by writing to Mead-Morrison.

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Manufacturing Engineers, Harrison, N. J.

Also builders of coal and ore bridges, coal and ore towers, buckets, pile hammers, and specially designed machinery.

MK-826

Figure 3 — Revealing and correcting dangerous conditions, such as this badly worn frog, is the primary objective of a track maintenance program. Properly organized, such a program will materially reduce the need for, and cost of, track repair and replacement.

THE ROADBED

The condition of the roadbed, particularly the drainage and ballast, is the single most important factor affecting the efficiency of railroad track. Ballast should provide a firm, even bearing for ties so that load is evenly distributed over the roadbed. Properly placed ballast assures adequate drainage of the track structure, keeping ties relatively dry and extending their service life. Good ballast discourages or prevents growth of weeds and other vegetation which gradually fouls ballast, reducing its drainage effectiveness.

During inspection of the roadbed, the following checkpoints should be covered:

1. Remove weeds, caked mud and other debris between and around ties.

2. Be sure ballast is evenly distributed between and around ties; ballast should be level with ties at center and gradually taper to 1½ to 2 in. below ends of ties.

3. Check shoulders; ballast should extend about 6 in. beyond end of ties, then slope sharply to subgrade.

4. Check for drainage; ballast should contain no depressed areas which would hold water.

5. Look for mud oozing up through ballast (indicates poor drainage under ballast).

6. Check general grade of track to determine that it has not settled too much since installation.

TIES AND TIE PLATES

Ties form the base of the track structure and act both as the bearing surface and anchor surface to which other components are fastened. In purchasing ties, it is important to deal with reputable firms which follow standard industry specifications concerning choice of woods, quality and cutting. The two most frequent causes of tie failure are mechanical damage and wear, and improper handling. Regular inspection of ties will reveal for correction those conditions which cause excessive wear.

Tie plates perform these functions: (a) distribute load from rail to tie; (b) give rail proper cant; (c) hold rail rigidly to gage; (d) protect tie from excessive wear. For industrial applications, used rather than new tie plates give adequate service. Periodic inspection of tie plates and rail fastenings is necessary to insure safety of the track installation. Such an inspection should include these points:

7. Inspect ties for checking, splitting or other defects which would allow moisture to seep in. (May require tie irons or application of hot asphalt or tar to prevent splitting.)

8. If tie plugs have been driven into ties to plug spike holes, check plugs for tightness.

9. Inspect ties for crushed fibers. (Should be removed by adzing. New creosote should be applied to fresh surface.)

10. Mark for removal any tie which has deteriorated to point where it is not sound enough to adequately anchor the track.

11. Inspect tie plates for proper spacing and position; should lie flat on tie with full width of shoulder of plate resting against base of rail.

12. Inspect tie plates for corrosive effects of brine drippings from refrigerator cars, sea water, etc. (May require application of hot oil with high asphaltic content.)

13. Check for loose or missing spikes; should be tightened or replaced.

14. Remove stones and other debris lodged between tie plates and ties.

15. Check position and condition of metal or asbestos sheets used to prevent ties from being burned at locations where switch heaters are used.

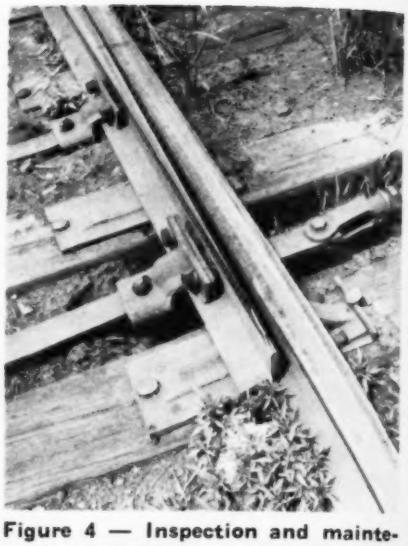

Figure 4 — Inspection and maintenance of turnouts are important. In cases of excessive wear or repeated damage, the installation should be examined to make sure that proper parts are being used and that turnout is designed for amount of traffic it handles. The switch shown above does not close properly because of poor adjustment. This has caused damage to the switch point.

RAIL AND RAIL JOINTS

Rails require little or no maintenance, but, as a safety precaution, should be inspected regularly for wear or damage. Rail should be replaced if it is broken, shows excessive wear or wheel burns, or is severely corroded at the base. When replacing rail, remember that substantial savings can be obtained by using "relaying" or reconditioned rail rather than new rail.

One of the most critical components of rail construction is the rail joint—a fastening used to unite rail sections into one continuous rail and to hold rail ends accurately and firmly in place to assure rail alinement. During inspection, particular attention should be paid to the condition and tightness of rail joints. Joint assemblies should be tight, but not tight enough to restrict rail expansion and contraction due to temperature changes. In a rail joint the heads of the first and third track bolt should be on the outside of the rail and the heads of the second and fourth bolts on the inside of the rail to prevent a derailed wheel from stripping all the nuts from a joint.

Rail joints should be replaced before they become so worn as to cause heavy batter and wear at the rail ends. Longer life for rail used on

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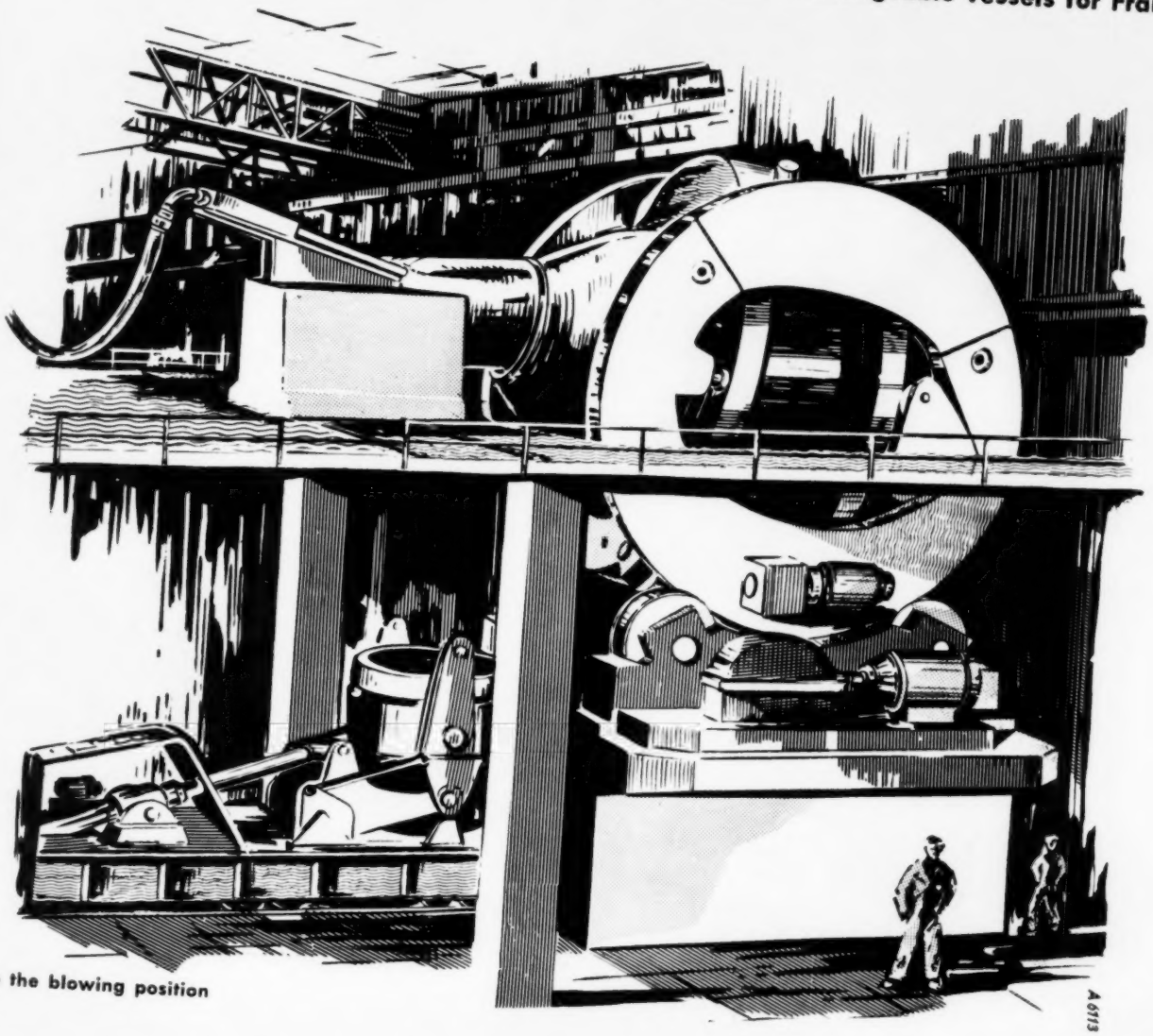
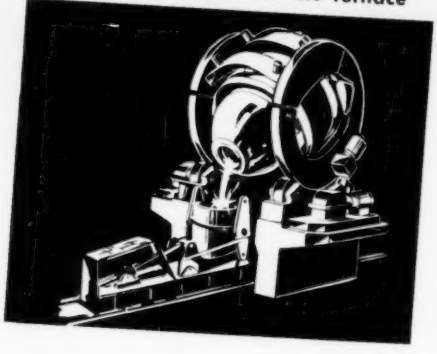


Furnace in the blowing position

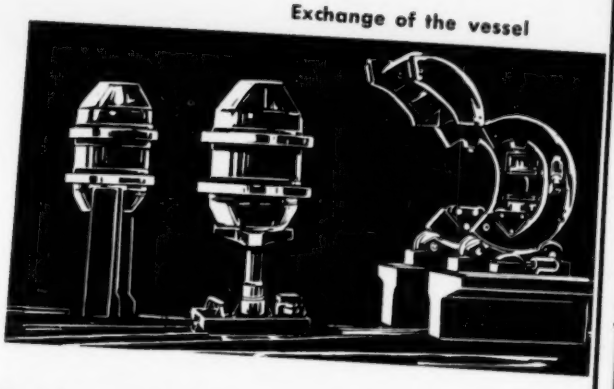
A 6113

metal being poured into furnace

Steel being poured from the furnace



Exchange of the vessel



U.S. Representative: AMERICAN DEMAG CORPORATION, Pittsburgh 22, Pa., One Gateway Center.

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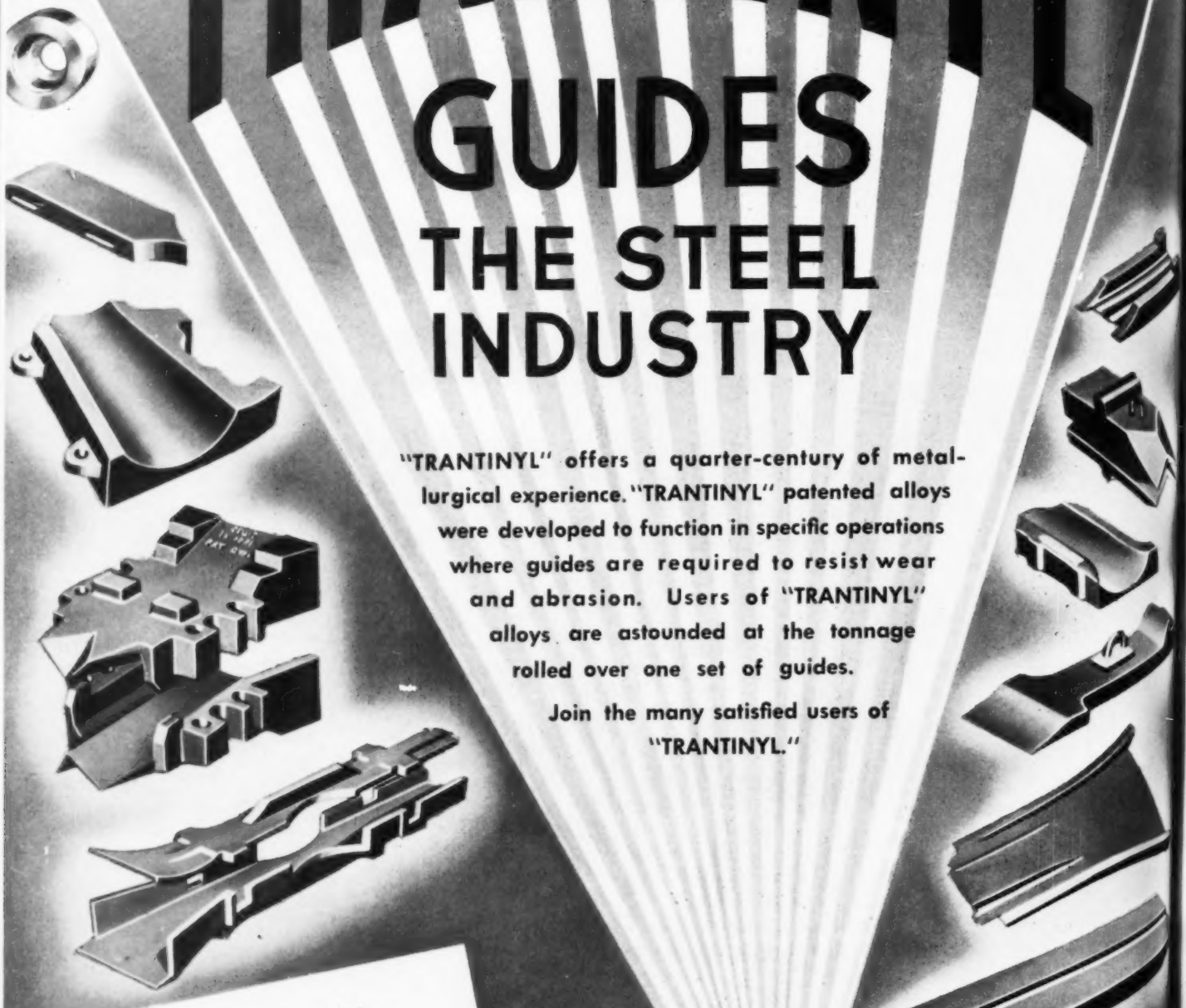

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

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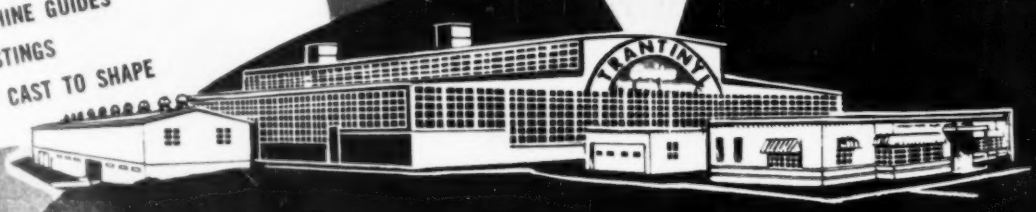


Youngstown Alloy Casting Corporation

Youngstown, Ohio

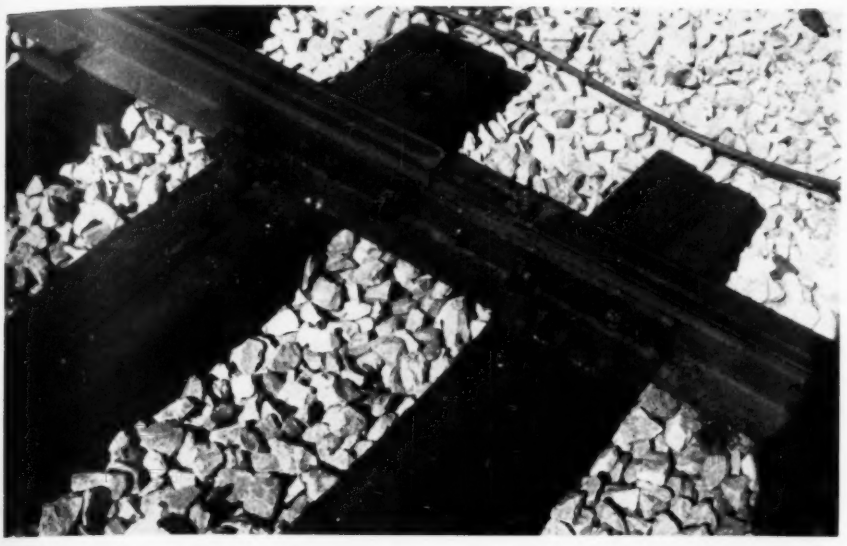


Figure 5 — This good example of a properly installed rail joint shows bolts alternated, adequate space between rail ends, tight spikes, clean ballast.

sharp curves can be obtained by replacing the "high" rail with new or relaying rail and substituting the "high" rail for the "low" rail.

Rail "creepage"—the longitudinal movement of rails under pressure of traffic—causes uneven surfaces and gage of the rails and misalinement of switches and switchgear. Indications of creepage should be watched for and corrected by straightening ties and installing rail anchors.

Rails should be inspected regularly for proper gage, surface and cross-level in order to anticipate as soon as possible necessary maintenance or repair work. Standard track levels and gages are used for this purpose. Inspection of rail and rail joints should include these points:

16. Inspect rail joints for tightness; joints should hold rail ends firmly in alinement. Joint bolts should be of uniform tightness. Missing lockwashers should be replaced.

17. Check for rail "creepage." Look for slewed ties, misalinement of switches and switchgear, closing of expansion joints in the direction of creeping, marks on rail flanges where spike heads scrape rails as they slide, crevices in ballast where ties have crowded ahead.

18. Inspect rails for battering, end overflow and chipping. ("Battering" is the mashing down of rail joints. "End overflow" is the projection of metal at top of gage side of rail head into gap between rail ends. "Chipping" is actual damage to rail surface.)

19. Check conditions of rails on curves to determine if replacement is necessary.

20. Inspect rails for proper gage, surface and cross-level. (If gage is incorrect it may be necessary to respike rail to proper gage and add gage rods.)

Figure 6 — Track properly maintained should look like this. Ballast is evenly distributed. Bolts on rail joint are alternated. Space between rail ends is adequate for expansion. Spikes are securely in place. Tie plates lie flat on ties. Ties are in good condition. There are no weeds.

SWITCH MATERIAL, ACCESSORIES AND TOOLS

Maintenance procedures for switches, frogs, guard rails and other components of a turnout are similar to those mentioned for rails, ties and other parts of the track structure. They should be checked for proper alinement and firm anchorage. Damaged or broken parts should be replaced promptly. In cases of excessive wear on repeated damage, the installation should be examined to be sure that the proper parts are being used and that the installation is properly designed. It may be necessary to install clamps, point protectors or other protective or fastening devices previously omitted because traffic conditions did not warrant their use.

Use of turnouts specially designed for industrial installations, rather than those designed for regular railroad use, will reduce the initial investment, cost of installation and cost of replacement parts.

Most auxiliary railroad equipment, such as bumping posts, car stops, derailers, etc., should be inspected regularly as a safety precaution. Tools used in track maintenance should be kept in good repair. A thorough track maintenance program will include these points:

21. Check switch rails for correct alinement with each other; check switch rods or bars for proper position and tightness.

22. Check security of rail braces used to hold running track to gage along switch length.

23. Check position and tightness of switch plates (also called slide plates) used to maintain proper elevation of switch rails. Plates should have smooth surface so that switch rails can move right or left.

24. Check position and tightness of gage plates used to relieve spike shear and wear on ties.

25. Check position and tightness of heel block used to hold heel end of switch rail in alinement horizontally and vertically with running rail.

26. Check tightness of switch point protectors.

27. Check for broken switch points; replace.

28. Check tightness of bolts in frogs.

29. Check wear and breakage at point of frog (caused by improper gage or defective wheels).

30. Check condition of switch stands; remove stones and debris that might interfere with performance. Check for visibility of targets and lamps.

31. In cold weather, check condition of switch point heaters; they should be ready for instant use. ▲

Bar Mill Design Reduces Need for Roll Changing

by A. E. Lendl, Chief Project Engineer, Schloemann A. G. Dusseldorf, West Germany

FOLLOWING an erection period of 14 months, Hoesch-Westfalenhütte A.G., Dortmund, Germany, on July 27, 1957, put into operation a merchant mill, the layout of which permits important reductions in or the elimination of downtimes due to roll and groove changing.

A point which had to be borne in mind by the designers was that European conditions do not favor the conventional layout of the fully continuous mill. Working to a widely varied program, calling for the production of comparatively small batches of different size sections, the percentage of downtime caused by frequent roll and groove changing might well have been too high to permit the desired monthly output of 25,000 tons.

Figure 1 shows the schematic layout of the mill. The mill consists of a six-stand roughing group, two four-stand intermediate groups with an edger, and two finishing groups featuring alternating vertical and horizontal roll stands for the last four passes. The first two stands have 17½-in. diam rolls, those of the subsequent ones are gradually reduced to 12½ in., the roll diameter of the final stands.

The roughing mill stands are driven in groups of two. Individual drives are provided from Stand No. 7 onwards. Total installed motor drive capacity is 14,750 hp, comprising thirteen 670-hp motors, six

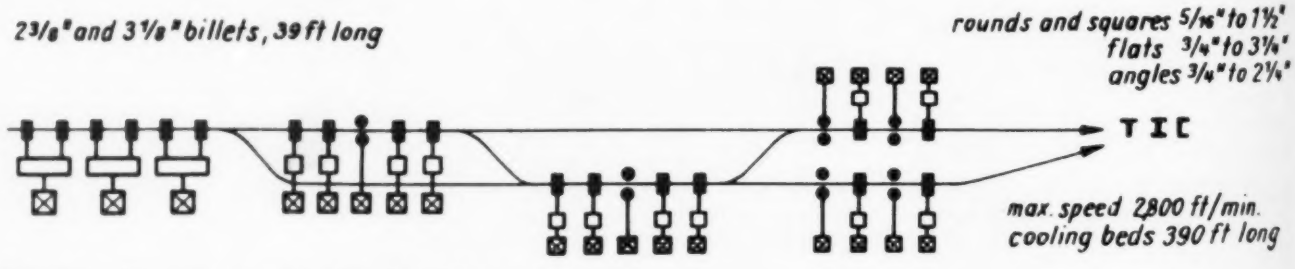

2 3/8" and 3 1/8" billets, 39 ft long
rounds and squares 5/16" to 1 1/2"
flats 3/4" to 3 1/4"
angles 3/4" to 2 1/4"
max. speed 2800 ft/min.
cooling beds 390 ft long

Figure 1 — Mill consists of 18 stands plus six edging stands.

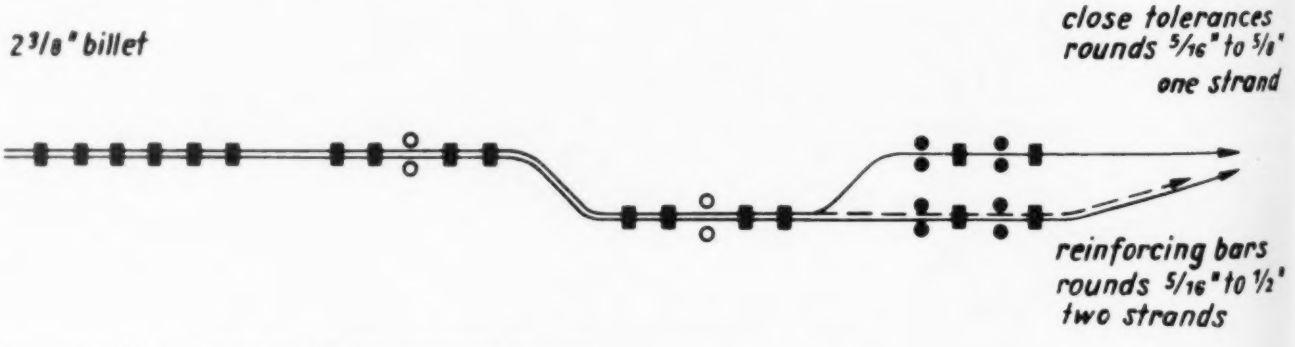
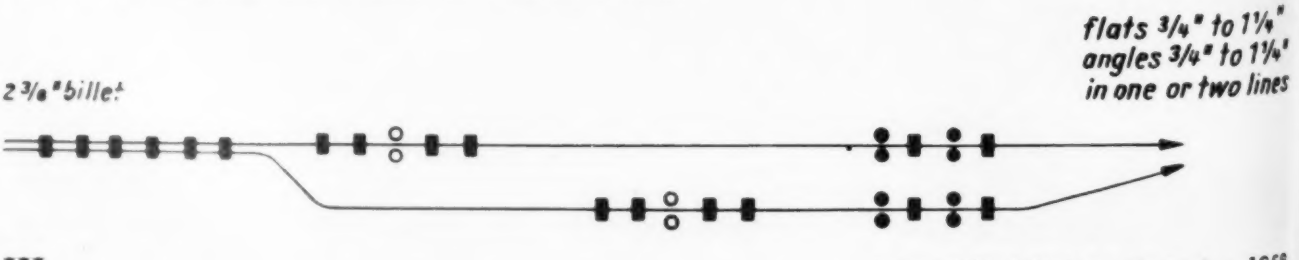


Figure 2 — All stands are used for rolling small sections.

Figure 3 — This layout is used for rolling flats and small angles.



Newly designed
Type H Motor Control

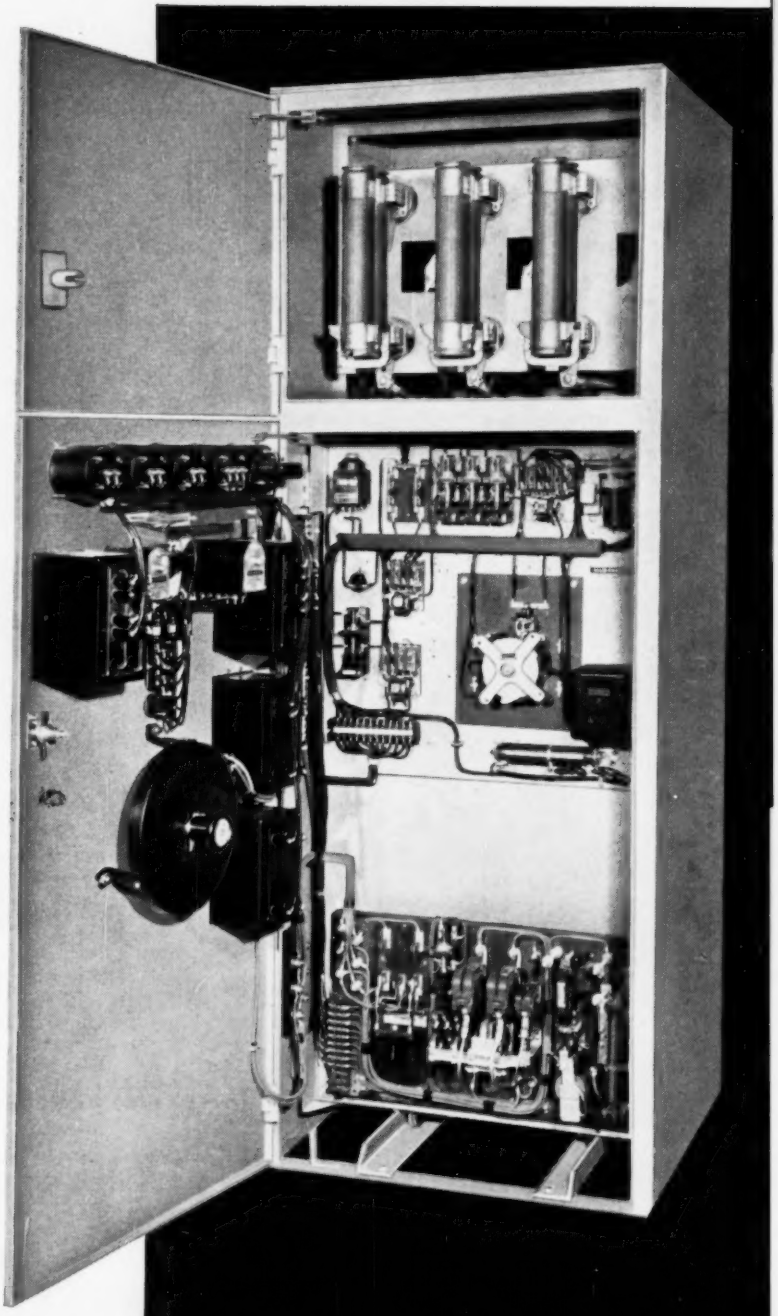
More room for optional features

Now, with Allis-Chalmers high voltage control, you get more panel space for additional components.

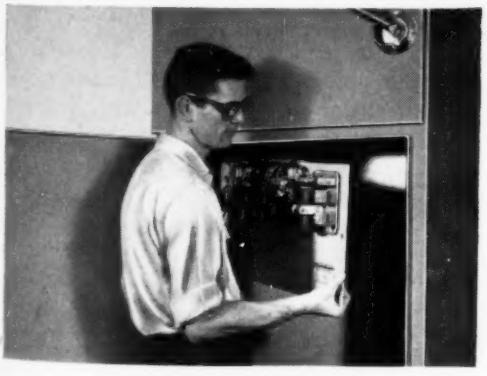
Meters, pushbuttons, instruments, rheostats, indicating lights, relays, and other components can be installed — thanks to the ample space available on both the outer door and inner barrier.

Along with more room, this new A-C design is front accessible, has smaller cabinet size, provides ultimate in protection for men and machines, and has been completely tested.

For more information on this engineering advance, contact your A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



All this area on Allis-Chalmers new Type H motor control is available for optional features. In many applications, this extra space eliminates the need for an extra cabinet.



Removable panel, on which control devices are assembled, is mounted on inner barrier. Entire panel may be quickly removed for inspection and maintenance.

ALLIS-CHALMERS A-C ALLIS CHALMERS

A-5519

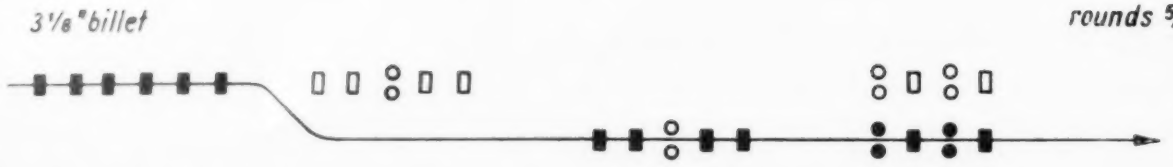


Figure 4 — One four-stand intermediate group is by-passed in the rolling of rounds up to 1⅛ in.

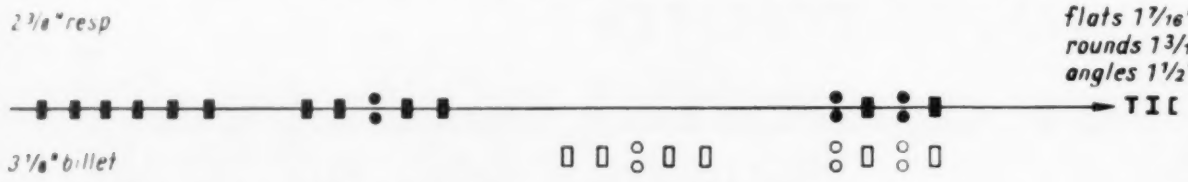


Figure 5 — This layout is used for rolling the larger flats, rounds and angles.

940-hp units and one of 200 hp to power the edger.

The rolling program includes rounds ranging from 5/16 in. to 1½ in. diam, the corresponding squares, flats from ¾ to 3¼ in., joists, channels and tees.

Tolerance specified for the rounds was ±0.006 in.

Furnace capacity is 80 tons an hour, the billets charged are 39 ft long, 2⅜ in. and 3⅛ in. square. Steel grades up to 0.9 per cent C are rolled.

Beyond the plant there is a 390-ft long double-sided rake-type cooling bed, which is designed for a maximum run-in speed of 2800 fpm.

The rolls have alternating diamond and square grooves for the first passes, followed by oval square and, finally, by oval round ones for the last six passes.

As will be seen in Figure 2, all stands are used for small sections. Starting section is 2⅜ in. square for rounds ranging from 5/16 in. to ⅝ in., having close tolerances. Concrete reinforcing rounds can also be rolled in two strands, through each of the two finishing groups, in 5/16- to ½-in. sections.

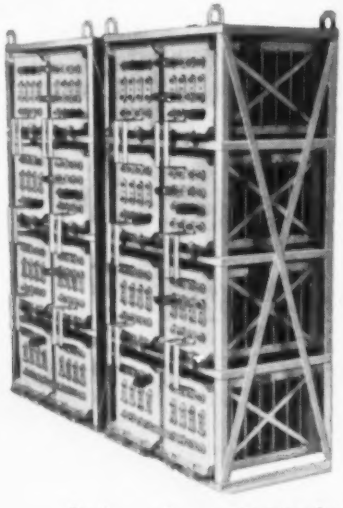
Figure 3 illustrates the rolling of flats and small angles. Initial section is again 2⅜ in. square. There is two-strand rolling in the roughing group, whereupon the strands separate, to enter an intermediate and a finishing group respectively, for reduction to ¾- to 1¼-in. flats and ¾- to 1¼-in. angles.

When handling larger sections, the mill can be divided into two independent plants, each with an intermediate and a finishing group, but with a joint roughing mill. While one group is rolling, the other is free for roll changing. Also, trial bars can be rolled on one side, to prepare a group for operation, while production continues on the other side.

Figure 4 illustrates the rolling of rounds from ⅝ in. to 1⅛ in. Initial section is 3⅛ in. square.

Figure 5 shows the rolling of 1 7/16- to 3¼-in. flats, 1½- to 2¼-in. angles, 1 3/16- to 1½-in. rounds, joists, channels and tees. The initial section is 2⅜ in. or 3⅛ in. square, depending on the final section.

The present production capacity is 20,000 to 25,000 tons a month. With a suitable rolling schedule and favorable sequence of sections produced, taking into account roll life and number of passes for the different sets of rolls, 80 per cent of the total rolling time available is expected to be utilized. If necessary the rolls in the first six stands can be changed during the third, free shift. In the intermediate and finishing groups, roll changing must be carried out during the normal fifty working shifts of the month. ▲



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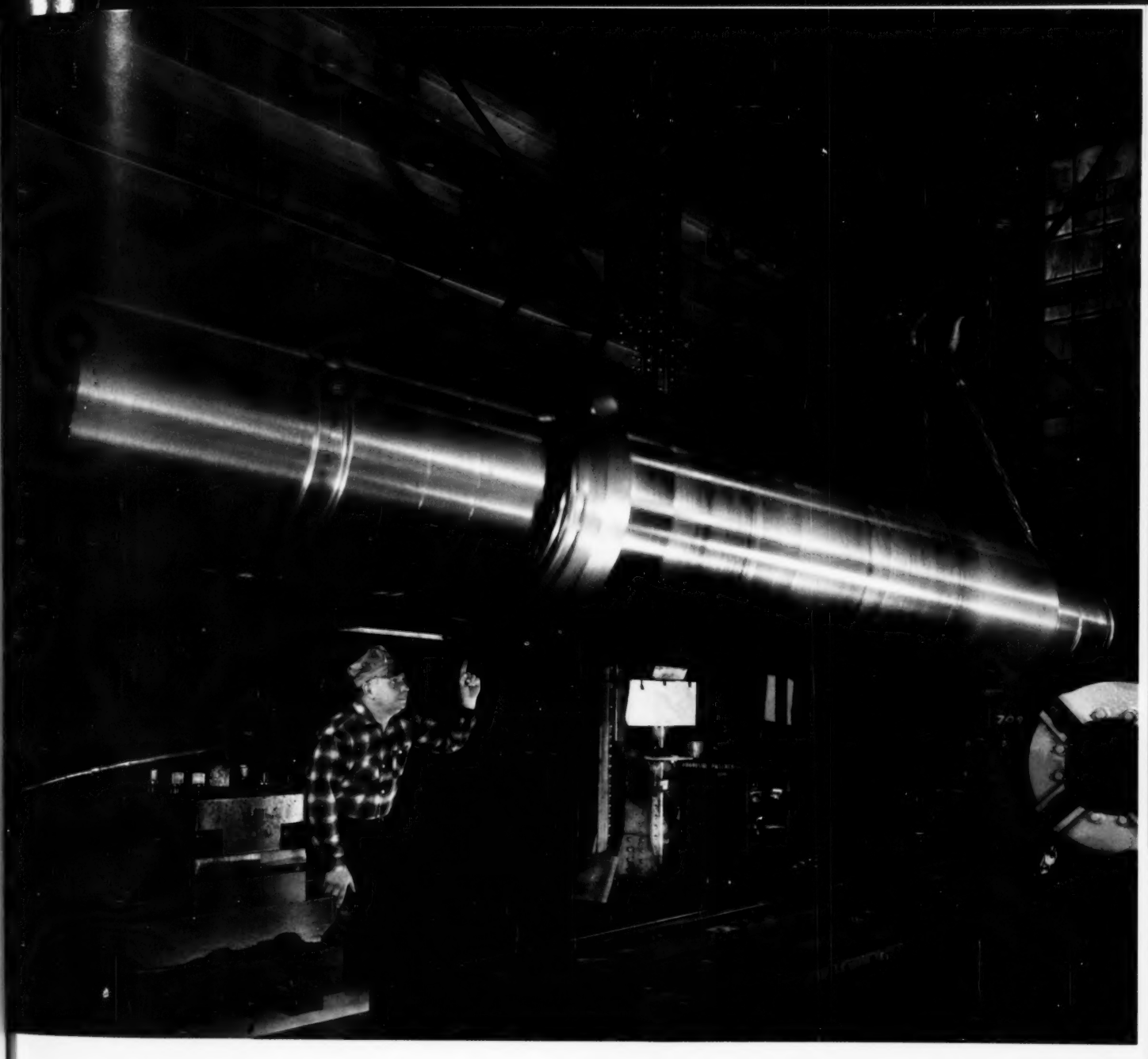

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...About three tons of it just came off in that lathe. For this "big boy" is a forty-ton plate mill roll—one of the largest made.

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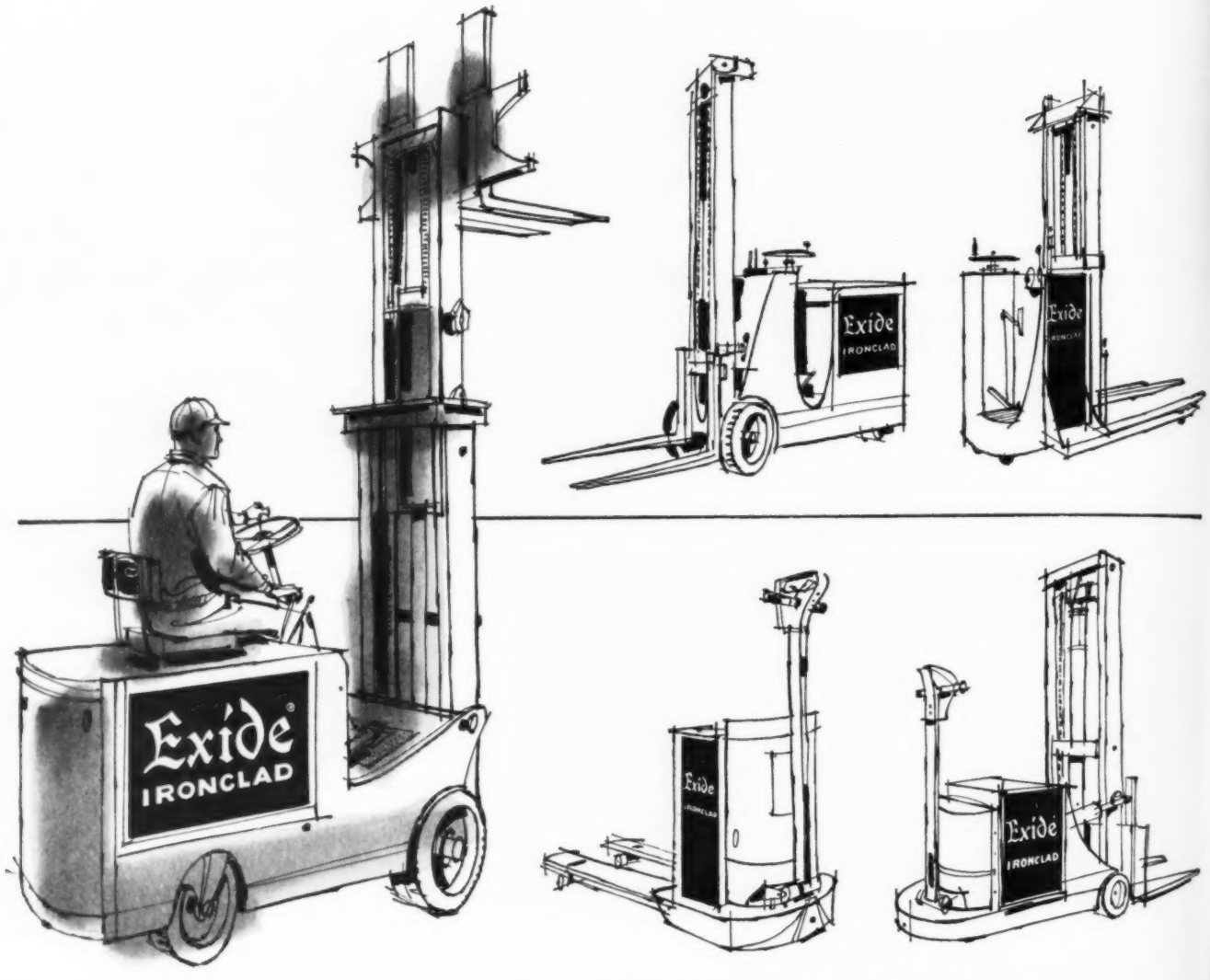

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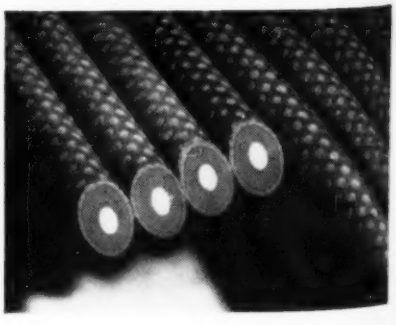

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H-W Super Plastic Fire Brick
Apache G (Plastic Fire Brick with Graphite added)
2900°F. H-W Black Patch (Plastic Fire Brick)
2800°F. Harcast (Castable)
2700°F. H-W Super Castable
2600°F. H-W Lightweight Castable 2600
Harchrome (Castable)
H-W Chrome Castable
2500°F. H-W Standard Castable
H-W Periklase Castable
H-W Baffle Mix (Castable)
2400°F. H-W Extra Strength Castable
2300°F. H-W 85 Lightweight Castable
2200°F. H-W 56 Low Iron Castable
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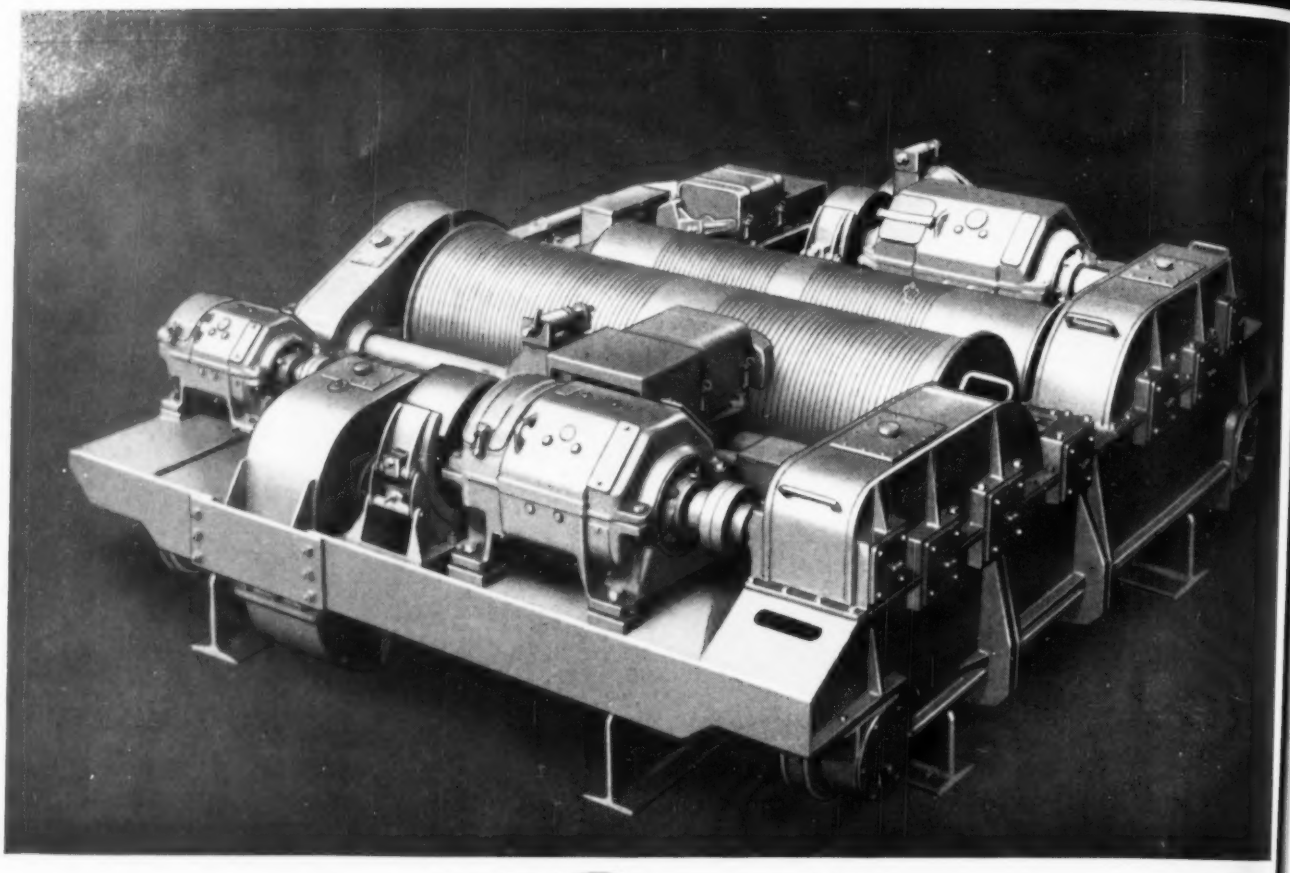

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				Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas. All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

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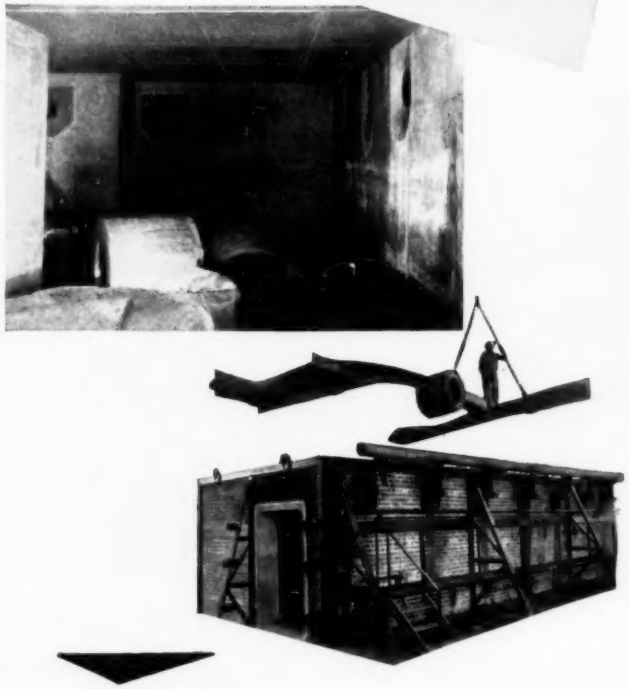
. . . "VERY SUCCESSFUL" —"EXPEDITES PRODUCTION"



That's what the man responsible for this 38′4″ by 23′4″ by 9′11½″ annealing furnace says of its complete one-piece Plibrico lining.

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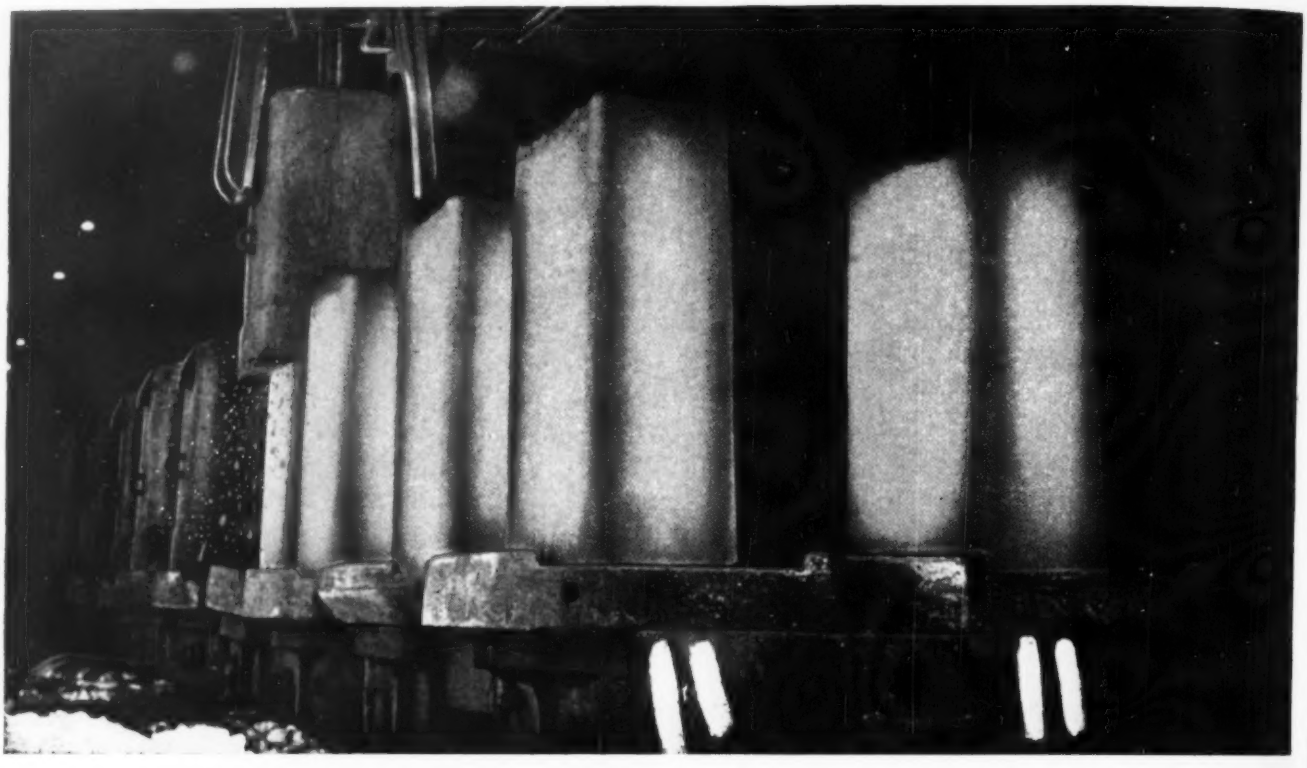

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1908–1958 GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS FOR STEEL INDUSTRY

Date-line Diary...

August 4

Δ Aluminum producers of the U. S. advanced prices 0.7 per lb to 24.7. Aluminium, Ltd., Canadian producers, also raised prices in the U. S., but its prices elsewhere were not changed.

Δ Consumer installment debt at the end of June, 1958 amounted to $33,000,000,000, a decrease of $127,000,000 from the May end total, but $446,000,000 higher than June, 1957.

Δ Prices were advanced by Pittsburgh Steel Co. with increases amounting to $7 per ton on oil well casing, $8 a ton on oil well tubing, and $10 a ton for drill pipe, grade D-internal upset, extras and deductions for other grades, threads, types of upset, etc., applicable.

Δ The AISI reports that the operating rate of the steel industry for the week of August 4 is scheduled at 1,611,000 tons (59.7 per cent of capacity). This compares with 1,561,000 tons one week ago (57.8 per cent capacity) and 2,043,000 tons one year ago. Index of production for the week is 100.3.

August 5

Δ Federal Reserve Board raised margin requirements for stock purchases and short sales to 70 per cent from the 50 per cent previously required.

Δ Government figures showed that construction expenditures in July, 1958 rose seasonally to $4,600,000,000, more than $200,000,000 higher than June, 1958 and $100,000,000 more than July, 1957. For the seven months of 1958 the total was $26,700,000,000, $200,000,000 above the same period in 1957.

Δ American Iron Ore Assn. reported that shipments of iron ore down the Great Lakes during July, 1958 totaled 9,589,436 gross tons, compared with 14,211,819 tons in July, 1957.

Δ The Bureau of Mines reported that production of Pennsylvania Anthracite for July, 1958, equalled 1,398,000 net tons compared with 1,995,000 in June, 1958 and 1,478,000 tons in July, 1957.

Δ The AISI reported that shipments of finished steel products for June, 1958 totaled 5,746,217 net tons compared with 4,649,499 tons in May, 1958 and 7,284,616 tons in June, 1957.

Δ The U. S. Dept. of the Interior, Bureau of Mines, reports that marketed production of natural gas in the United States for the first quarter of 1958 totaled 2,903,000,000,000 cu ft, consumption totaled 3,334,800,000,000 cu ft.

Δ United States Steel Corp. and its general operating divisions, American Steel and Wire, Columbia-Geneva Steel, National Tube, and Tennessee Coal and Iron Divisions, announced price increases averaging approximately 3 per cent for carbon and alloy bar and semi-finished products, and for carbon rods, wire, tubular products and cold rolled strip.

August 6

Δ Bethlehem Steel Co. announced price increase for hot-rolled plates, structural shapes and sheet piling of about 3¼ per cent; Barium's subsidiary, Phoenix Iron & Steel Co., increased price of carbon steel plates to $106, up $4 a ton, structural shapes were increased $4.50 to $111 a ton; Crucible Steel Co. of America boosted prices of high-speed tool steels and related types between 2 and 5 per cent; A. M. Byers Co., marked up prices on 4-D wrought iron products 3 per cent.

Δ The Commerce Dept. estimated book value of all inventories held in manufacturing and trade lines as of June 30 were $86,500,000,000, down $400,000,000 from the month-earlier level; sales of manufacturing and trade concerns in June rose approximately $800,000,000 above the $52,400,000,000 in May, 1958.

August 7

Δ United States Steel Corp. announced a downward revision in prices for its stainless steel plates, reflecting an average reduction of approximately 6 per cent.

Δ United States Steel Corp. and its operating divisions, Columbia-Geneva Steel and Tennessee Coal and Iron Divisions, announced increases averaging approximately $4.25 per net ton in prices on plates, structural shapes, and sheet piling.

Δ The AISI reports estimated payroll for the iron and steel industry for June, 1958, amounted to $266,065,538, compared with $257,965,765 in May, 1958, and $310,205,988 in June, 1957. Estimated total employment was 510,828 compared with 500,369 in May, who worked an average 35.5 hours a week in June compared with 34.2 in May. Average hourly payroll cost per wage earner was $3.113 compared with $3.095 in May and $2.862 in June, 1957. Totals for the first six months of 1958 were: payroll, $1,566,973,202 (hourly and salary); average hourly payroll cost, $3.087; total employment, 516,547; average hours per week for wage earners, 34.3.

Δ Federal Trade Commission Chairman John W. Gwynne said past investigations found no price-fixing in the steel industry and indicated the commission does not plan any action on the latest price increases.

Δ Custom smelters cut copper prices ½¢ to 26½¢ lb.

Δ Universal-Cyclops plans August offering of $22,500,000 sinking fund debentures, due 1978; it will use $10,300,000 of proceeds to retire a term bank loan and apply the remainder to expansion of facilities.

Δ Universal-Cyclops reported net income of $822,972, or 51¢ per share for the first half of 1958; net income in the second quarter amounted to $723,531.

August 11

Δ The AISI reports that the operating rate of the steel industry for the week of August 11 is scheduled at 1,656,000 tons (61.4 per cent of capacity). This compares with 1,586,000 tons one week ago (58.8 per cent capacity) and 2,062,000 tons one year ago. Index of production for the week is 103.1.

Δ Government figures showed that unemployment at July 15 declined to 5,294,000, down 143,000 from mid-June level. Employment rose to 65,100,000 at mid-July, an increase of 198,000.

August 12

Δ The Agricultural Dept. predicted that crop production this year will be the highest in the nation's history, placing total output at 113 per cent of the 1947–49 average.

Δ The AISI reports that steel production of ingots and steel for castings during July amounted to 6,370,000 net tons, compared with 7,127,480 tons in June, 1958, and 8,908,732 tons in July, 1957. Total for the first seven months of 1958 totaled 44,122,487 tons compared with 69,492,279 tons in 1957.

August 14

Δ Government figures showed that personal income rose to a seasonally adjusted rate of $354,500,000,000, up $2,500,000,000 above the June pace.

Δ Price of lead in New York was reduced by custom smelters to 10¾¢ a lb down ¼¢; price in London is 8.77¢ a lb, down from 9¢.

Δ F. W. Dodge Corp. midyear review reports that the cumulative total of contracts for future constructions in the first six months of 1958 amounted to $16,788,625,000, one per cent under the comparable 1957 period.

August 18

Δ The Senate Finance Committee voted $283,000,000,000 for a new Federal debt limit which exceeds the present limit by $8,000,000,000; a temporary debt limit of $288,000,000,000 was voted for through June 30, 1959.

Δ The AISI reports that the operating rate of the steel industry for the week of August 18 is scheduled at 1,678,000 tons (62.2 per cent of capacity). This compares with 1,632,000 tons one week ago (60.5 per cent capacity) and 2,101,000 tons one year ago. Index of production for the week is 104.5.

Δ United Engineering and Foundry Co. report for the six months ended June 30, 1958 shows income amounting to $51,655,321, net profit $2,726,739 or $1.10 per share; compared with total income of $41,682,386, net income of $2,712,420 or $1.10 per share for the same period of 1957.

Δ The Bureau of Mines reported that the consumption of scrap during June, 1958 totaled 4,407,000 gross tons, pig iron used was 4,059,000 gross tons; this compared with 3,862,491 tons of scrap and 3,691,550 tons of pig iron in May, 1958.

August 20

Δ The Commerce Dept. calculated the seasonally-adjusted annual rate of gross national product for the April-June quarter at $429,000,000,000, $1,000,000,000 over the estimate last month by the President's Council of Economic Advisers.

Δ The ARCI reports that deliveries of new domestic freight cars in July, 1958, totaled 2113 compared with 2407 in June, 1958, and 7725 in July, 1957. Orders in July totaled 317 compared with 317 in June and 1251 in July 1957. Backlog of cars on order as of August 1, 1958 stood at 25,994 compared with 27,757 a month earlier and 85,229 on August 1, 1957.

Δ The Aluminum Assn. reported primary aluminum production in the United States during July, 1958 was 118,811 short tons compared with 115,325 short tons in June, 1958, and 142,041 tons in July, 1957.

August 21

Δ Securities and Exchange Commission reported that new corporate securities offered in the second quarter this year declined to $2,900,000,000, down $400,000,000 from the first quarter; debt issues for the half year totaled $5,400,000,000 compared with $5,100,000,000 in the first half of 1957.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in July, 1958 were $5,169,000, compared with $3,672,000 in June 1958. New orders for induction heating equipment in July amounted to $503,000 compared with $602,000 in June, 1958.

Δ Universal-Cyclops have delayed indefinitely the public offering of $22,500,000 of 20-year sinking fund debentures scheduled for August 26 due to current market conditions.

August 25

Δ The Aetna-Standard Engineering Co. annual report for the year ended June 30, 1958 shows sales of $31,301,279, net income of $1,236,795 or $2.44 a share, compared with sales of $43,411,427, net income of $1,418,741 or $3.07 per share for the year ended June 30, 1957.

Δ A combined report of Dept. of Commerce and Dept. of Interior indicates total shipments of iron and steel castings for 1957 were 15,294,000 short tons, 9 per cent below 1956 shipments. Consumption of iron and steel scrap and pig iron in the United States in 1957 totaled 150,000,000 short tons, 3 per cent less than in 1956.

Δ The AISI reports that the operating rate of the steel industry for the week of August 25 is scheduled at 1,717,000 tons (63.6 per cent of capacity). This compares with 1,690,000 tons one week ago (62.6 per cent capacity) and 2,103,000 tons one year ago. Index of production for the week is 106.9.

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in July, 1958, totaled 104,004,000 lb, compared with 106,364,000 lb in June, 1958; shipments of aluminum foil in July, 1958 totaled 14,455,039 lb, compared with 14,587,071 lb in June, 1958.

August 27

Δ The Commerce Dept. reported that world steel output annual rate for the first half of 1958 is 288,000,000 net tons, down from the 322,000,000 ton record level of 1957.

Δ AISC reports that bookings of fabricated steel in July, 1958 totaled 330,890 tons compared with 286,798 tons in June, 1958 and 213,175 tons in July, 1957; shipments in July, 1958 totaled 290,856 tons compared with 329,240 tons in June, 1958 and 342,486 tons in July, 1957. Backlog as of July 31 was 2,219,610 tons.

August 28

Δ The Internal Revenue Service made final its rule on employee expense accounts, effective with the 1958 tax year. Expenses reported and reimbursed in like amount will not have to be reported on income tax forms; any allowance in excess of expenses must be reported as compensation; and employees who do not account for business expenses to employers must report them on tax returns.

Δ The F. W. Dodge Corp. reports that construction contracts in the United States in July totaled $3,607,056,000, 24 per cent over July, 1957.

Δ Shipments of iron and steel castings for June, 1958 totaled 1,012,691 short tons compared with 955,362 tons in May, 1958 and 1,284,667 tons in June, 1957.

August 29

Δ Copper prices were reduced ½¢ to 26¢ a lb by custom smelters; quotations for scrap were also shaved ½¢.

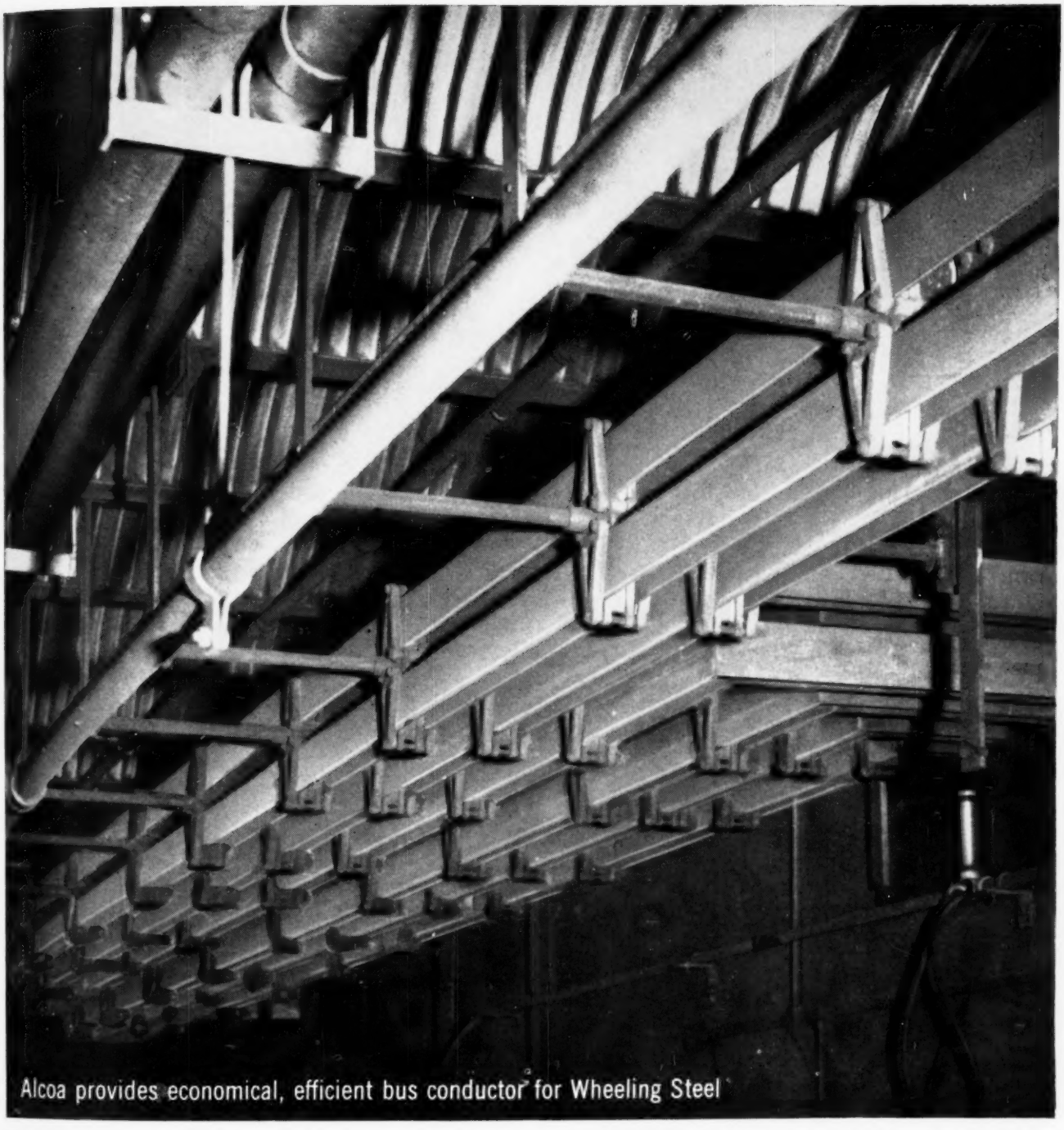
Δ Japan production of crude steel for June, 1958 totaled 985,000 metric tons.

August 31

Δ Commerce Dept. reported that manufacturers new orders in July rose to $26,300,000,000 a gain of $500,000,000 over June, 1958; inventories in July declined $400,000,000 to $49,800,000,000, compared with a $700,000,000 drop during June, 1958.

Δ Effective January 1, 1959 the social security taxes from workers will be 2½ per cent on the first $4,800 compared with the present 2¼ per cent of $4200; payments to retired persons will increase 7 per cent in February, 1959.

Δ Bethlehem Steel Co. has increased mill base prices on rails and track accessories, effective September 2, approximately 3¼ per cent.



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Now STATIC POWER Adjustable Speed Packaged Drives

No moving parts . . .

Cutler-Hammer *ULTRAFLEX*® *DRIVES* provide outstanding savings in installation—operation—maintenance

No moving parts! Light, compact static power conversion units have replaced the conventional m-g set. Ultraflex Packaged Drives save up to 50% in valuable floor area . . . up to 75% in weight, permitting rapid, low cost installation or rearrangement of production machinery without special handling equipment or floor loading preparations.

No moving parts! Ultraflex Packaged Drives provide a new high standard of operational efficiency and ultra-responsive speed control. Works perfectly without forced ventilation . . . less power wasted as unwanted heat. No power robbing friction or windage losses.

No moving parts! Simple static power conversion units require only a fraction of the time and effort needed to maintain conventional rotating type drives. With Ultraflex, there are no bearings, commutators, or brushes to service. No shafts to align. No couplings to maintain. No inertia loads to balance. No fans or filter to clean or change.

Ultraflex Packaged Drives come complete with operator's station, static power conversion unit, and heavy duty D-c drive motor. Standard Ultraflex Drives provide an 8:1 speed range with wider ranges available upon request. Optional features include dynamic braking, jogging, reversing, tach-generator speed regulation, etc.

Cutler-Hammer also provides a complete engineering service which will custom-design a static powered adjustable speed drive to meet your specific requirements. Get all the facts today, write on your company letterhead for new bulletins EN64-T232 and EN65-T232. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

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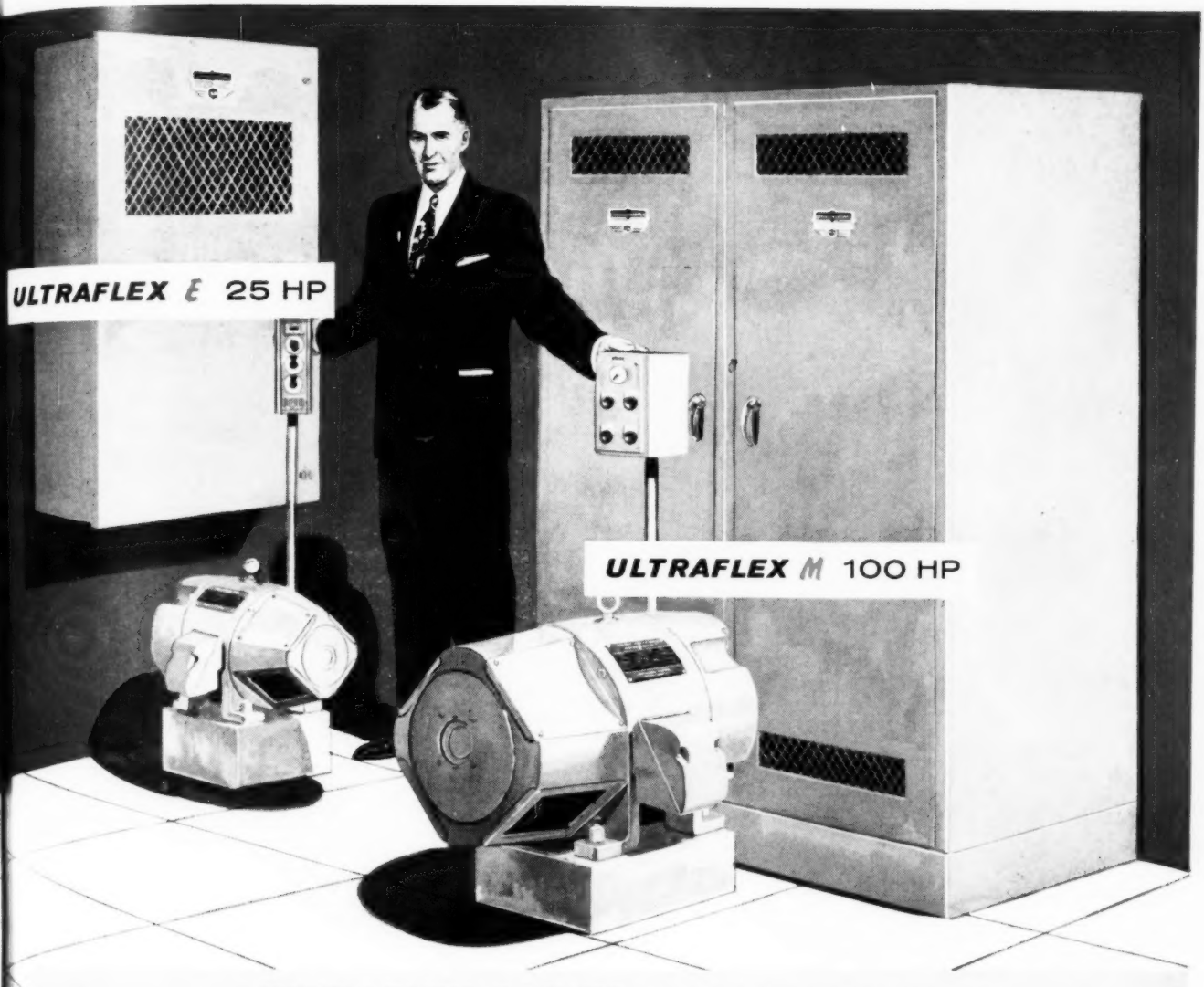
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.



ULTRAFLEX DRIVES Pack More Power per Square Foot... More Power per Pound

HP	CONVENTIONAL m-g DRIVES SQ. FT.	CONVENTIONAL m-g DRIVES LBS.	ULTRAFLEX—E SQ. FT.	ULTRAFLEX—E LBS.
5	3.89	543	Wall Mounted	215
7½	3.89	550	Wall Mounted	215
10	5.44	647	Wall Mounted	215
15	7.0	983	Wall Mounted	330
20	9.5	1830	Wall Mounted	330
25	9.5	1990	Wall Mounted	330
30	9.5	2120	6.46	625
40	13.8	2350	6.46	625

HP	CONVENTIONAL m-g DRIVES SQ. FT.	CONVENTIONAL m-g DRIVES LBS.	ULTRAFLEX—M SQ. FT.	ULTRAFLEX—M LBS.
5	3.89	543	3.5	660
7½	3.89	550	3.5	870
10	5.44	647	3.5	870
15	7.0	983	3.5	1000
20	9.5	1830	3.5	1000
25	9.5	1990	4.5	1250
30	9.5	2120	4.5	1250
40	13.8	2350	4.5	1250
50	17.8	2980	11.7	2200
60	23.3	4070	11.7	2200
75	23.3	4800	11.7	2200
100	25.2	5700	11.7	2400

ULTRAFLEX E 1 HP to 40 HP

Electronic Type Adjustable Speed Drives

Ultraflex E is the simplest, most flexible, most dependable electronic adjustable speed drive on the market today. Heavy duty power tubes have replaced all "radio type" components assuring maximum efficiency and maintenance-free operation. Standard features of design include a closed loop voltage feed back system for accurate voltage regulation, current limit control, and static rectifier field excitation. Compact design permits wall mounting of the control units up to 25 HP.

ULTRAFLEX M 1 HP to 200 HP

Magnetic Amplifier Type Adjustable Speed Drives

Ultraflex M Packaged Drives set new standards for ultra-efficient, ultra-responsive operation. Fully 15% more efficient than conventional rotating type drives, the static magnetic amplifier power conversion unit avoids all power losses due to friction, windage and the necessity of transferring power across multiple air gaps as in rotating machinery. Standard Ultraflex M drives are equipped with a closed loop voltage feed back system with IR compensation for accurate voltage regulation, current limit control, and static field excitation.

2 to 3 times Greater Thrust Capacity

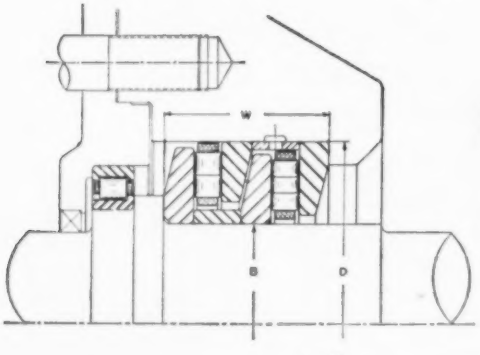
8 to 12 times Longer Life Expectancy

New ROLLWAY TANDEM THRUST BEARING

Using axial space along the shaft, rather than enlarging the housing diameter, this new Rollway tandem thrust bearing distributes the load over two or three stages of roller components. Gives 2 to 3 times more thrust capacity than conventional thrust bearings. Life expectancy is 8 to 12 times longer depending upon the number of stages.

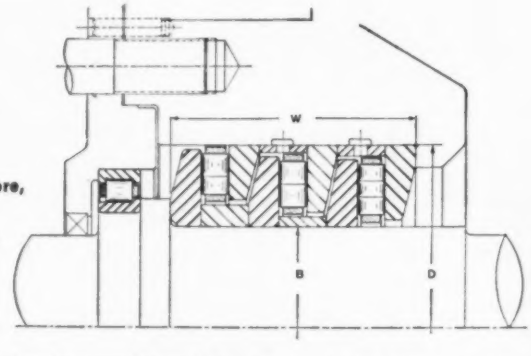
Each stage comprises a rotatable bearing plate . . . a bronze retainer with thru-hardened steel rollers . . . a compression sleeve . . . and a stationary bearing plate. The thrust load is applied to the first stage and is by-passed by each compression sleeve in turn to the remaining stage or stages.

Calculated deformation of the bearing plates distributes the load uniformly on all rollers. A greater number of rollers in the first stage carries about 60% of the load, without increasing the load per roller. Compression sleeves have cross-sectional areas proportional to the load imposed. Roller variance is held within one ten-thousandth inch.



✓ **TWO STAGE TANDEM**

22 sizes, up to 17" bore, 34" O.D., and 2,325,000 lb. capacity at 100 rpm



✓ **THREE STAGE TANDEM**

5 sizes, up to 17" bore, 34" O.D., and 3,410,000 lb. capacity at 100 rpm

SEE this remarkable bearing at the AISE Show (Booths 479-80), or write Rollway Bearing Company, Inc., 541 Seymour Street, Syracuse 4, N.Y. for catalog sheet giving complete specifications.

ROLLWAY® BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

Tandem Thrust Bearing manufactured by Rollway Bearing Company, Inc. under U.S. Patent Number 2,374,820.

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Idling at 70° below zero—or pushing at 127°

one NATIONAL TRADE-MARK brush fits both jobs!

H. H. FRASCH

These mammoth material movers push, carry, pull and lift over terrain that stops many machines. Working temperatures vary as much as 200 degrees, says H. H. Frasch, "National" Carbon Brush Man.

Rugged brushes are vital, Frasch continues, because each wheel is geared directly to a high torque DC motor.

For motors and generators, the manufacturer chose "National" Brush grade SA-45. RESULT: excellent cold weather performance, even under idling and stalling loads—excellent tropical performance, even where commutator speeds reach 5,000 RPM.

Further, NATIONAL CARBON's one-brush solution simplified brush ordering and gave the customer maximum quantity discounts. Call *your* "National" Brush Man next time you have a problem or write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

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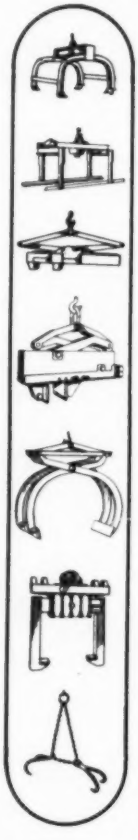
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

No. 5

Facts About:
MANSAVER®
GRABS

MOTOR-DRIVEN END HOOK
a patented MANSAVER feature makes full Crane Control possible



Sheets requiring end support are handled with maximum safety when Mansaver Motor-Driven End Hooks are used. One motor adjusts the end hooks to the various lengths of sheets, handles and keeps them from sagging. Another motor adjusts the legs of the grab for sheet width. Horizontal motion of the sheet carrying angle eliminates the need for lifting the grab when adjusting it to sheet width.

Mansaver grabs are available in manual, semi- and fully-automatic, and motor-operated models for lifting sheet, coils, rod, and other steel mill products. New grabs are being developed constantly. Tell us your problem.

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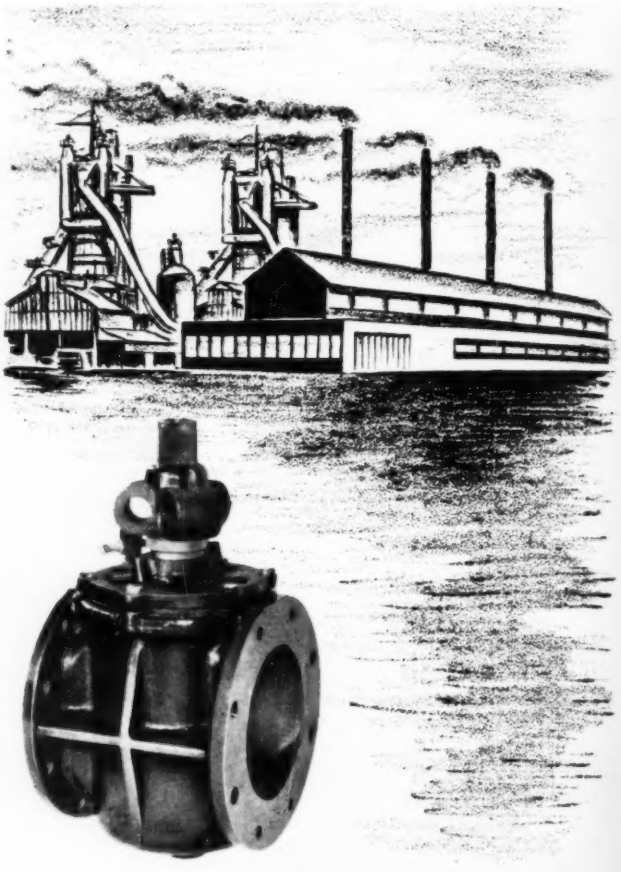

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The uses — and value — of DeZurik Valves in steel plants have grown every day. Their unique design principle enables them to handle a wide variety of services — including some of the most difficult. DeZurik Valves are the *only* valves with

ECCENTRIC ACTION

This exclusive principle pivots the plug eccentrically, matching the eccentrically-raised seat. The resilient-faced plug touches the seat *only when the valve is closed,* sealing tight despite solids in the flow! The first fraction of the opening quarter-turn backs the plug away from the seat, and it swings aside without sticking — without friction — without lubrication!

ASK THE DeZURIK REPRESENTATIVE in your area for more information on these unique valves. They're available in sizes from ½" thru 20" with manual operation or a complete range of remote operators, and in a wide variety of metals.

Or write to

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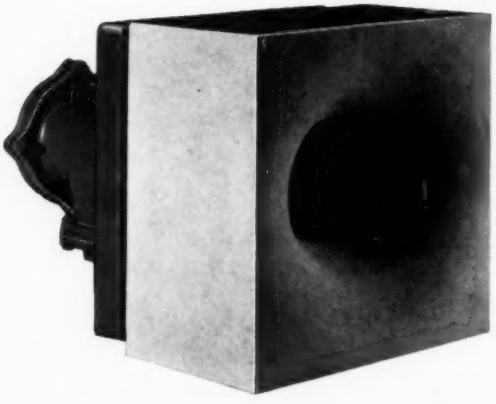

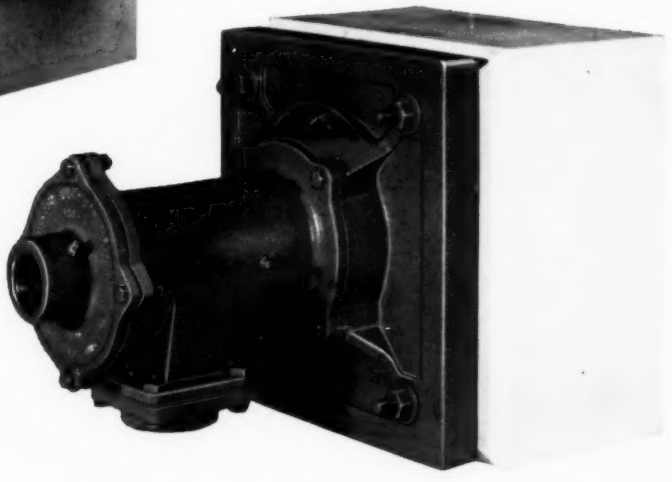

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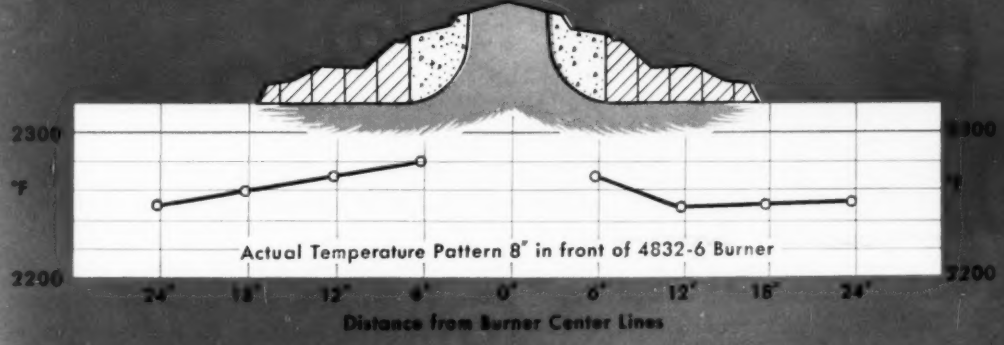
Fire Directly Without Flame Impingement
Flame Shape Adjustable • Ultra-Stable • Wide Fuel-Air Ratio Range



For engineering information consult your nearby N. A. office or write for Bulletin 4832 ▼

The North American Manufacturing Co.
COMBUSTION ENGINEERS
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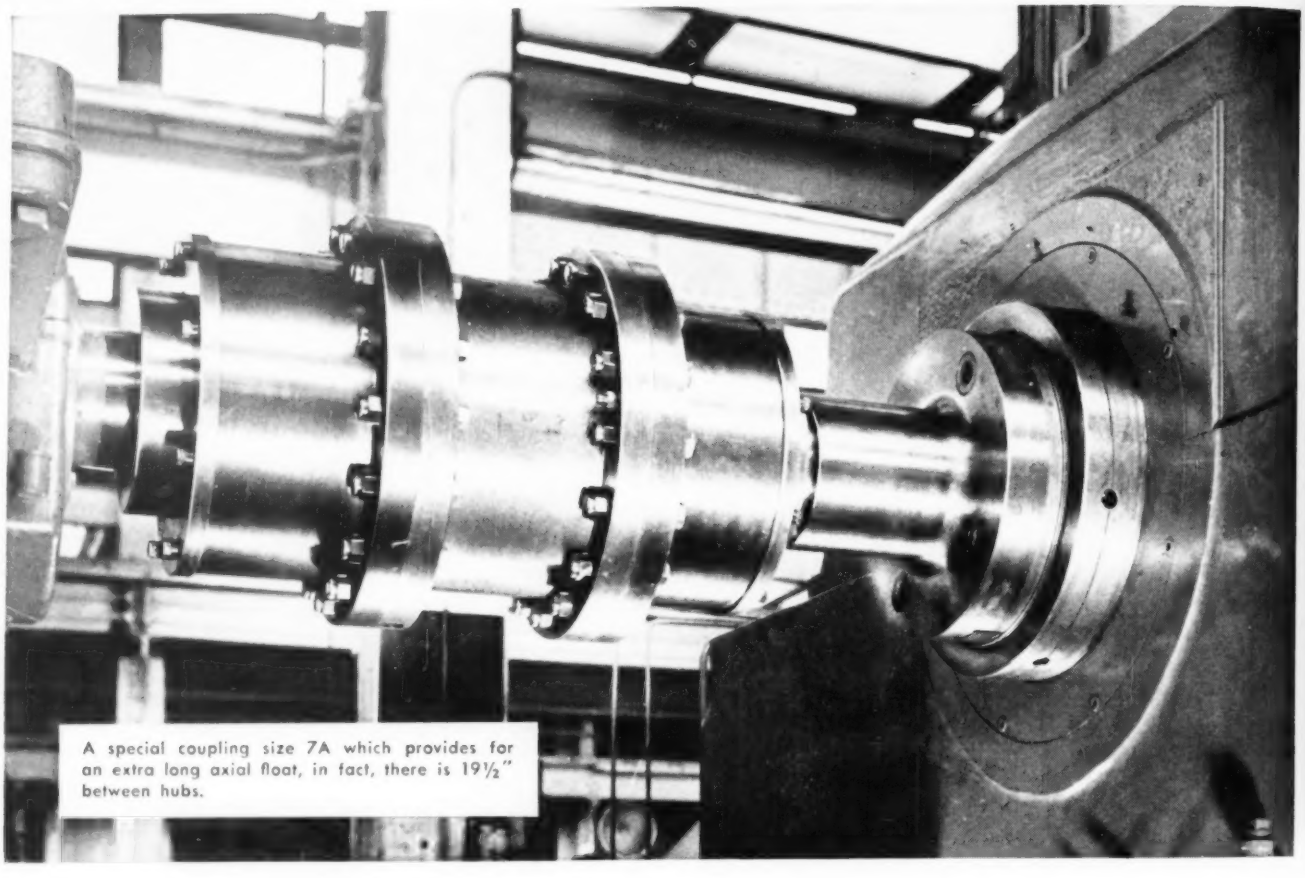
SPECIAL COUPLING PROBLEMS



A special coupling size 7A which provides for an extra long axial float, in fact, there is 19½" between hubs.

SOLVED

at JOHN WALDRON

From time to time, manufacturers are faced with special power transmission problems which cannot be handled by standard couplings. Sometimes they need a coupling for exceedingly high speed drives, sometimes a coupling for very large diameter shafts and for other special applications.

John Waldron, which is well known for its ability to produce high quality couplings also makes excellent special couplings to customer requirements. In the past, Waldron has made couplings that turn at speeds over 50,000 RPM, couplings which can take over 45,000 HP and couplings for particular applications such as continuous lubricated couplings, spacer types, shear pins, cut-outs and couplings for many other special installations.

If you have a particular power transmission problem that needs a special coupling, call or write the John Waldron Corporation in New Brunswick, New Jersey. Their long experience in designing, and manufacturing couplings for special problems, may have already solved your problem for you.

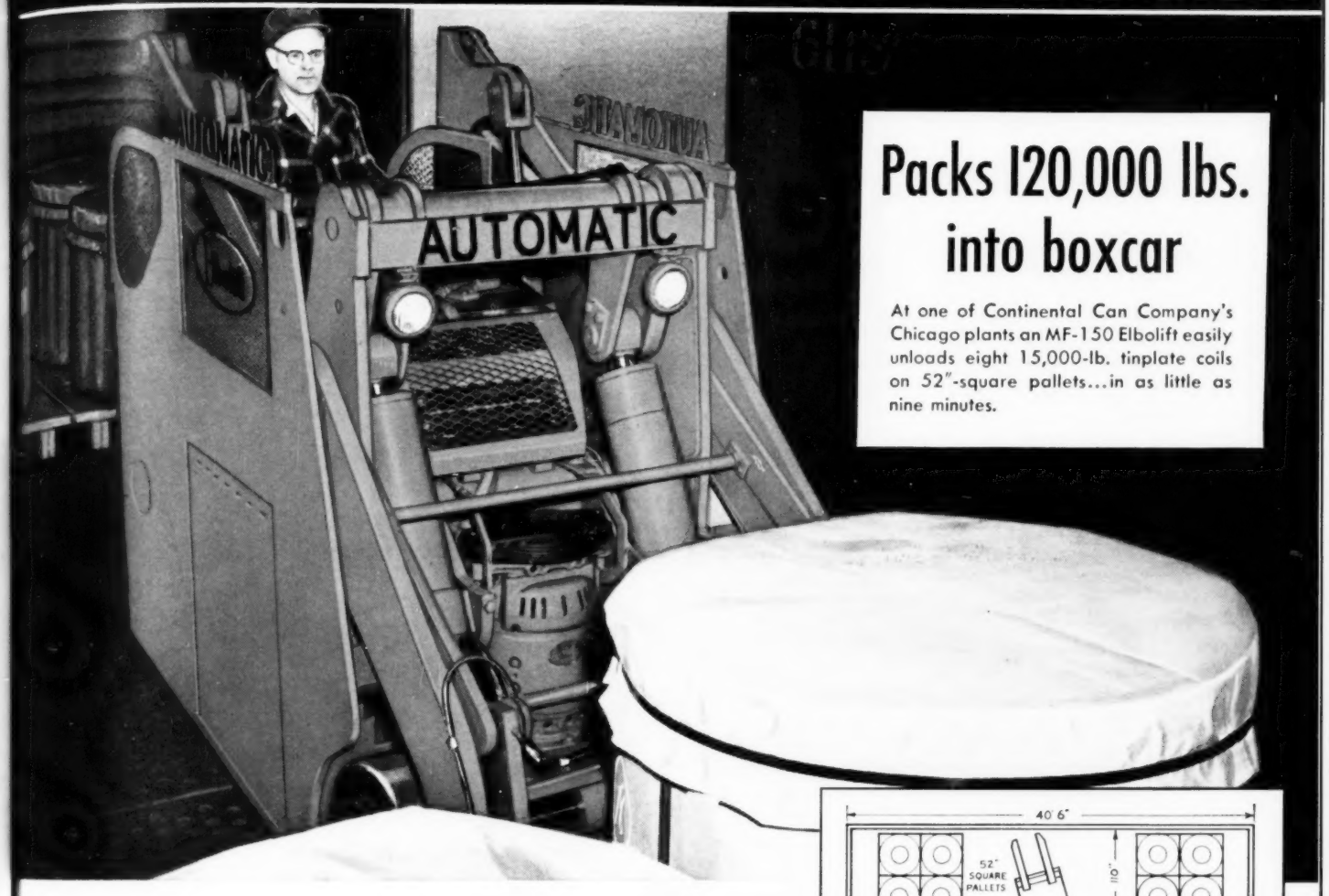
MR

JOHN **WALDRON** CORP.

A subsidiary of Midland-Ross Corporation

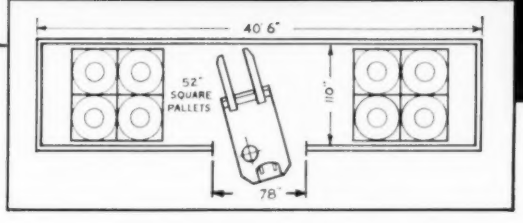
New Brunswick, New Jersey

NEW HEAVY-DUTY CARLOADING SENSATION



Packs 120,000 lbs. into boxcar

At one of Continental Can Company's Chicago plants an MF-150 Elbolift easily unloads eight 15,000-lb. tinplate coils on 52"-square pallets...in as little as nine minutes.



Automatic Elbolift does more work... handles heavier loads in less space.

High Stacking in Tight Quarters—Note operator's wide field of vision for stacking while maneuvering in a 53"-wide aisle. End gate optional equipment.

Automatic Elbolift's radical departure in design from the conventional mast-type truck has achieved these superior qualities for working in confined areas:

Compact Design....Elbolift with its stand-up end control design can operate easily through a 78" boxcar door with a 52"-square load.

Increased Visibility....Makes maneuvering in tight areas a snap.

Reduces Weight....Lowers floor loading requirements: for example, a 15,000-lb. capacity Elbolift weighs up to 6,000 lbs. less than a comparable mast-type truck.

New Inching Control....4 speeds forward and reverse with foot inching to any speed pre-set or selected by control handle.

Improved Load Distribution....Since tires take up ⅔ of Elbolift's 48" overall width... 32 lineal inches of tire contact with floor provides better distribution of load.

High Stacking....Built-in retraction feature maintains maximum stability every inch of its 120" lift.

But there are many more advantages, all fully described and illustrated in an informative brochure that is yours for the asking. No obligation; just mail the coupon. Ask about Automatic's convenient lease and purchase terms.

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Industry News...

AMERICAN STEEL AND WIRE ANNOUNCES PLANS TO CONSOLIDATE RANKIN AND DONORA WORKS

Δ Plans to consolidate the Rankin Works and the Donora Steel and Wire Works of American Steel and Wire Division were announced by L. F. McGlincy, Pittsburgh District operations manager of the United States Steel Corp. division. Mr. McGlincy said that to effect the consolidation the 72-year-old Rankin Works will be closed about November 1, and the operation moved to Donora.

Economic reasons and obsolescence of equipment at the Rankin Works necessitated the move, Mr. McGlincy said. Increased operational efficiency to meet highly competitive market conditions will result from combining the two operations.

Mr. McGlincy pointed out that production at the Rankin Works has fallen steadily for a number of years. The plant reached its peak in 1924, when shipments totaled 138,000 tons, and even as late as 1956 it shipped 61,000 tons of steel products. Last year, however, it dropped to 37,000 tons.

"In view of the cost penalty imposed by its low level of operation, we have already kept the plant in production longer than its economic usefulness would warrant," Mr. McGlincy said. "To retain our markets, we must maintain the lowest possible production costs. With idle production capacity at Donora, it would be impractical to invest in new, more efficient equipment for the Rankin Works, particularly at this time, when inflationary forces have pushed the cost of replacement to such high levels. Our decision was made after long and serious consideration of all these factors and a continuing concern for the employees at the plant."

Mr. McGlincy said that every effort will be made to assist the approximately 250 Rankin Works employees in obtaining other employment.

"In addition," he declared, "the various benefit programs in existence, such as severance allowances, pensions and supplementary unemployment benefits will aid in the necessary adjustments."

The Rankin plant was established in 1886 as a common-products mill. It was acquired by U. S. Steel in 1902 for the production of steel strapping wire, merchant wire, nails, staples, barbed wire, woven fence, wire hoops and metal reel parts.

GRANITE CITY OXYGEN PLANT GOES ON STREAM

Δ The Granite City Steel Co. has brought into production another key unit in its expansion program, a large oxygen generating plant built by Air Products, Inc.

The oxygen generating system will supply Granite City with about 60 million cu ft of oxygen a month, almost six times the amount it has been obtaining from two smaller generators. Most of the new supply is being piped to the company's seven open hearth furnaces to (1) increase flame temperatures and (2) accelerate the removal of carbon from the molten steel during the "refining period" in the furnaces.

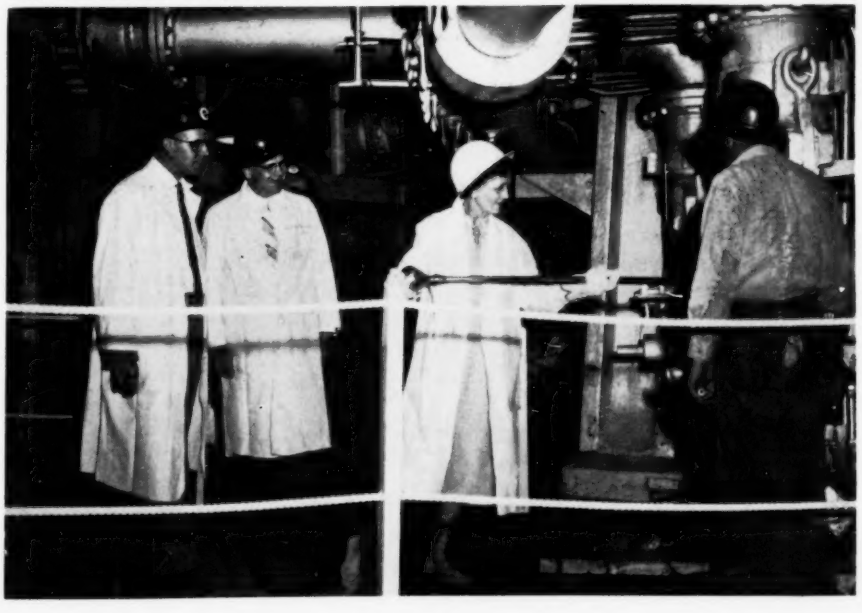
The increased use of oxygen is one of the means Granite City is using to raise the annual steelmaking capacity of its open hearth furnaces to a new high, scheduled to be reached sometime in 1959, of 1,584,000 tons.

The new generator separates oxygen from the air of which it is a part by compressing the air under a pressure of about 2500 lb psi (normal atmospheric pressure at 70 F, is 14.7 lb psi). The air is then allowed to expand and, in so doing, rapidly absorbs heat and lowers the temperature around it to and slightly below the point—minus 297 F below zero—at which air changes from a gas to a liquid.

The two other principal gases in air, nitrogen and argon, are separated from the oxygen by taking

REBUILT BLAST FURNACE LIGHTED AT HOMESTEAD

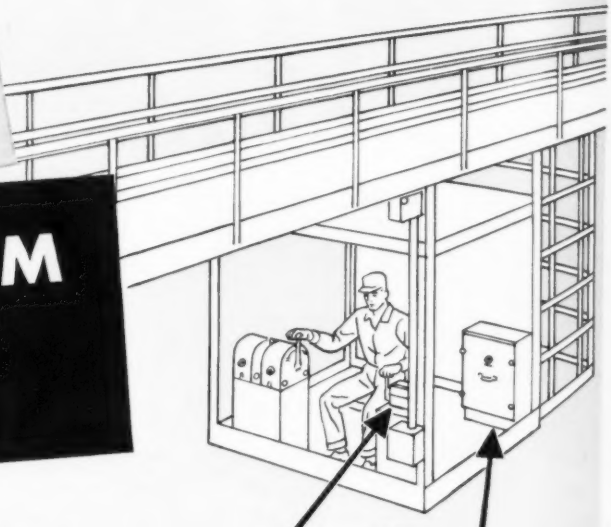
Mrs. Robert W. Graham, wife of the general superintendent of United States Steel Corp.'s Homestead District Works, inserts a lighting rod through a tuyere to light the rebuilt No. 3 blast furnace in the plant's Carrie Furnaces Division in Rankin. Looking on are William Bennett (left) Carrie Furnaces Division superintendent, and Mr. Graham (center.) Number 3 furnace, featuring a 28-ft diam hearth and equipped with modern, automatic controls, has the highest rated production capacity of any blast furnace operating in Western Pennsylvania—499,100 tons of iron per year.



Better than Manual Control for So Many Reasons!

NEW LOW COST EC&M MAGNETIC CONTROL FOR DC CRANES

Now, on any DC application up to 55 HP, 230 volts, you can have the advantage of full *magnetic* control where manual control formerly was specified purely on the basis of price. At comparable cost, EC&M's new *Type PT* Magnetic Control gives you—



"PT" CONTROLLER
with front cover removed

Compactness—fits easily in crane cabs, on crane walkways and wherever space is limited.

3-Point Speed Control in either direction.

Reduced Motor Wear through automatic acceleration. Acceleration relays adjustable from 0.2 second up to 3 minutes per step.

Space Saving—front connection permits mounting against wall.

Maximum Safety—completely enclosed.

Fewer Spares—no manual control parts to stock.

Choice of Mounting Arrangements—MA Master Switch can be ganged with other masters or self-contained on top of the PT Controller.

Standardized Overload Protection is available. Separate panel for protection of 1 to 4 motors is smaller, simpler than protective panels used with manual controllers.

Write FOR BULLETIN 6131

Available for Hoist, Bridge and Trolley motions on cab or floor-operated cranes

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
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advantage of the fact that they "boil off"—change from a liquid back to a gas—at lower temperatures than oxygen, which remains behind as a pale blue liquid. Returned to gaseous form, the oxygen is stored under pressure in banks of steel cylinders 80 ft high until it is distributed by pipeline in the steel plant.

The new generator is being leased to Granite City Steel by Air Products, Inc., under an arrangement which provides for oxygen supply over a 15-year period.

PILOT OPERATION BEGINS AT LOUISVILLE PLANT

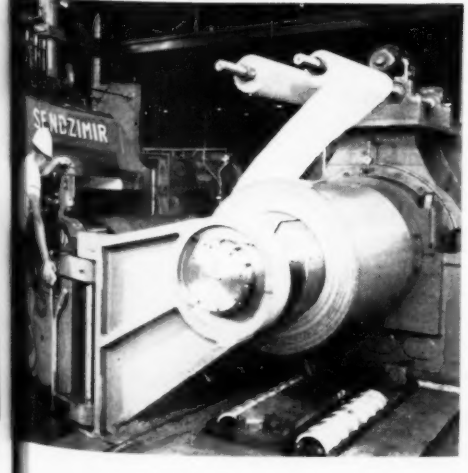
Δ Installation work at Jones & Laughlin Steel Corp.'s new Stainless and Strip Division Plant at Louisville, Ohio, is nearing completion and pilot production is now underway, M. K. Schnurr, Division President, has announced.

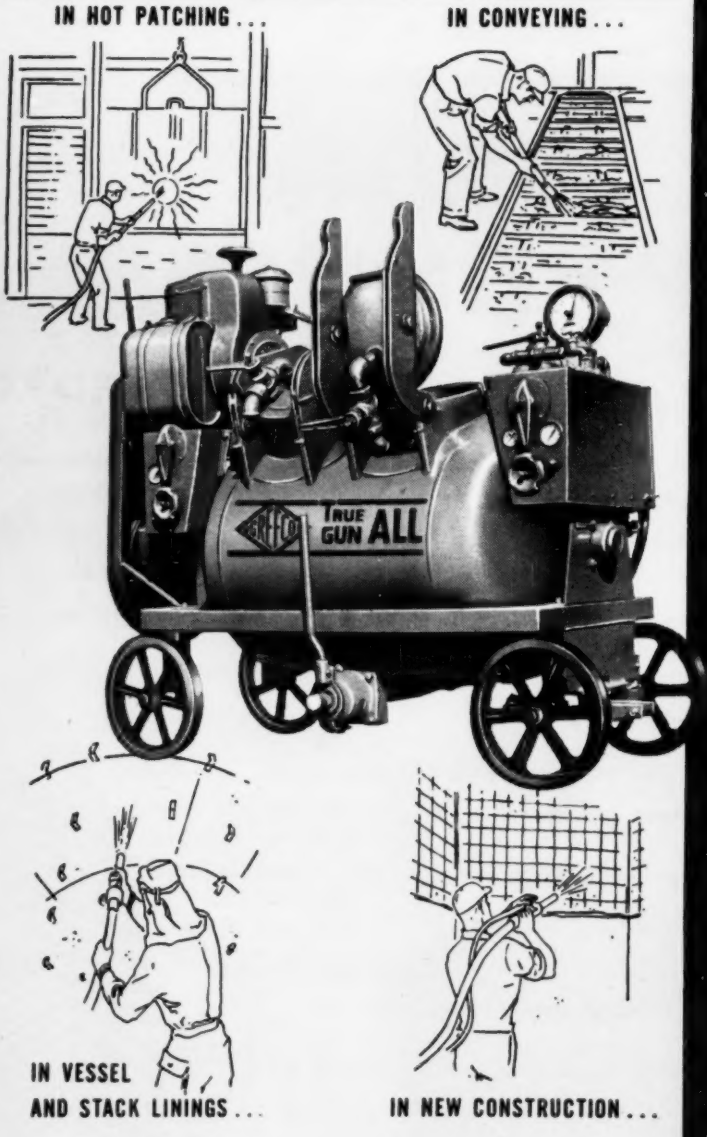
According to Mr. Schnurr, first shipments of finished flat-rolled stainless products began in August and adequate inventories are being produced to meet market needs.

When completed, the $17,000,000 plant will have a capacity of 3000 tons monthly of stainless steel sheet and strip in both the 300 and 400 Series.

The employment of personnel to operate the plant is practically completed. Wherever possible, new employees were enlisted from the Louis-

Shown in pilot operation at J&L's Louisville, Ohio, plant is the new 52-in. Sendzimir ZR22-50 cold rolling mill. Roller is checking the sheet of stainless steel. First shipments of finished stainless began in August.





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• In numerous ways, in numerous industries, the GREFCO TRUE GUN-ALL is proving a revolutionary advance in pneumatic refractories application.

Here, at last, is a *true* all-purpose, wet mix refractory gun, handling a complete range of materials for *all* applications.

The GREFCO TRUE GUN-ALL allows *faster*, easier and more economical placement of GREFCO refractory products:

- **CHROME GUN MIXES**
- **HIGH DUTY FIRECLAY MIXES**
- **MAGNESITE GUN MIXES**
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- **COMPLETE RANGE OF CASTABLES**

Write for full information on the GREFCO TRUE GUN-ALL and gun mixes.

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GEAR LUBRICATION

ENCLOSED • SEMI-ENCLOSED • OPEN GEARS

Since 1876 the Brooks Oil Company has been a specialty manufacturer of petroleum products for the industrial lubrication field.

Among the best known products manufactured by Brooks are LEADOLENE-KLINGFAST lubricants. They are particularly adaptable to open, enclosed and semi-enclosed gears.

Compounded to meet rigid specifications . . . having the following desirable characteristics:

High pH-ilm Strength. Minimum of 25,000 lbs. per square inch, (Timken testing machine).

Adhesiveness. Affinity for steel and other metals . . . restricting creep, leakage and losses.

Water Repellance. Retards washing off . . . creates rapid separation from water.

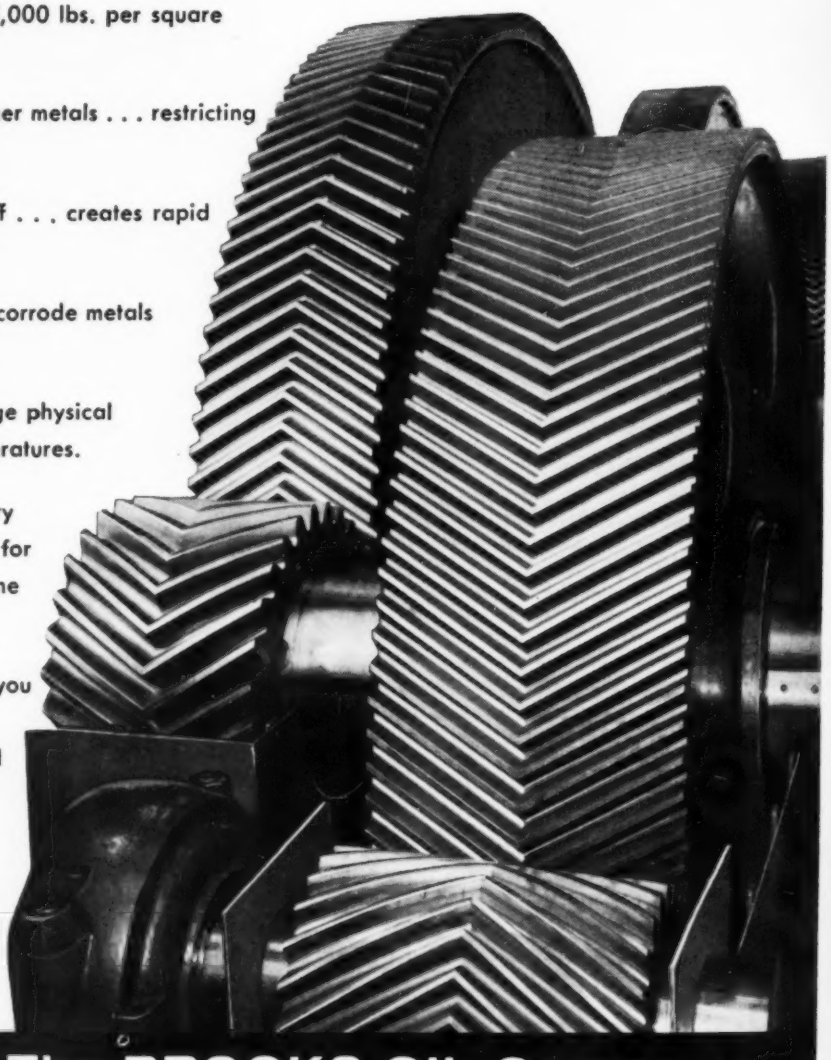
Corrosion Prevention. Will not etch or corrode metals . . is an excellent protective coating.

Compounded Stability. Does not change physical condition under normal operating temperatures.

Low Temperature Factors. Extraordinary channel point for plastics and pour point for fluids . . . satisfactory lubrication with same grades in summer or winter.

With LEADOLENE-KLINGFAST lubricants you profit in two ways: Lowered lubrication costs due to less frequent application and greater service life from the machinery being lubricated.

A new 16 page brochure available on request



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Established 1876

General offices and U.S. plant: 3304 East 87th Street • Cleveland 27, Ohio

Canadian offices and plant: 461 Cumberland Avenue • Hamilton, Ontario

ville area. However, because of the highly specialized skills required to operate the equipment, it was necessary in many cases to bring in experienced personnel from other areas.

All of the production equipment in the plant is new. It includes a 52-in. Sendzimir cold rolling mill, built by Waterbury Farrel Foundry & Machine Co., with the heaviest drives yet used on a mill of this type.

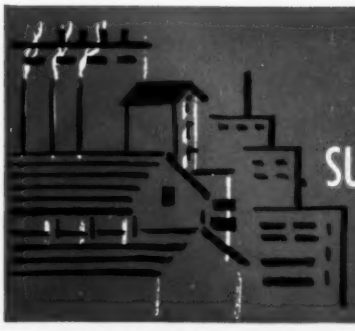
EGYPTIANS OPERATING HELWAN STEEL PLANT

Δ On July 23, Egypt's first integrated iron and steel works, which has been set up in the vicinity of the former spa town of Helwan, was inaugurated by the president of the United Arab Republic, Gamal Abdel Nasser. The Helwan Works is scheduled to produce 265,000 tons of ingot steel annually, a capacity which is to be increased to 500,000 tons at a later stage. When the Works is finally completed Egypt will be in a position to meet its present needs of ingot steel almost entirely from its own production.

The Egyptian Iron & Steel Co., Société Egyptienne pour le Fer et l'Acier SOCEFA—was called into existence for the execution of the project. Its share capital of 19 million Egyptian pounds is in the hands of the Egyptian government, the Misr banking group and a large number of private persons of Egyptian nationality.

The first part of the Works, which has now been completed, comprises two blast furnaces, a steelworks, rolling mills and all necessary auxiliary plant. The blast furnace plant includes a blower tank. The steelworks has an inactive mixer, three basic Bessemer converters, two electric furnaces and lime and dolomite kilns. The rolling mills comprise 1 two-high reversing blooming mill with soaking pits set up in front, 1 three-stand two-high blooming and finishing mill, as well as a three-high mill for heavy and medium plate and a two-high stand for sheet. The mills have an annual production of 200,000 tons of billets, rails, sections, heavy and medium plate and sheet. Part of the output of billets will be dispatched for further processing to other small rolling mills already established in Egypt.

The iron and steel works is to have its own power station for the



Safe and Efficient
SUPERVISORY CONTROL OF
SUB-STATIONS

A NEW FEMCO CONTROL SYSTEM

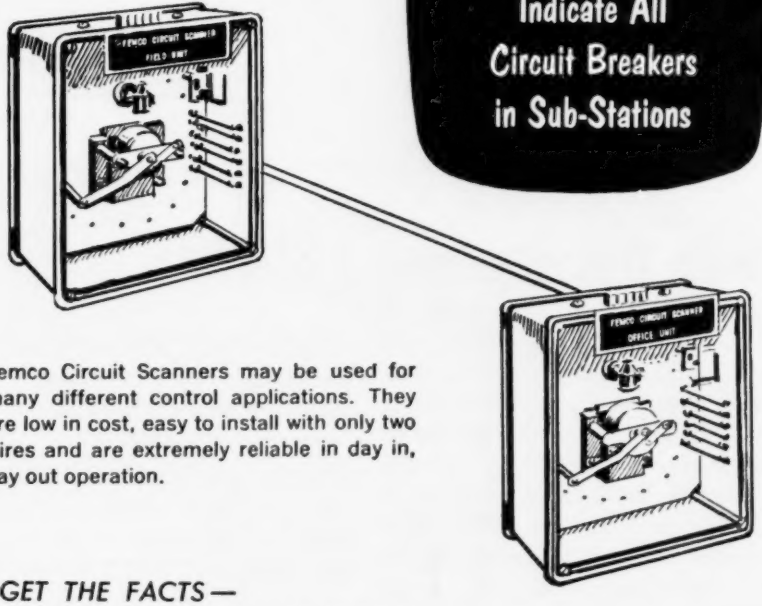
New Femco Circuit Scanners Now AC or Battery Operated

Because the control equipment is powered from a separate source independent of the equipment being monitored, systems are safer to use with little chance of simultaneous power failure.

Systems may be installed to operate all on AC power or AC with standby battery or all battery-powered. Regardless of power used, the system always will be in synchronization.

Using a single pair of wires, the system will provide supervisory control of all circuit breakers in sub-stations. Any number of stations may be wired to a central control cabinet in a single system.

Control and Indicate All Circuit Breakers in Sub-Stations

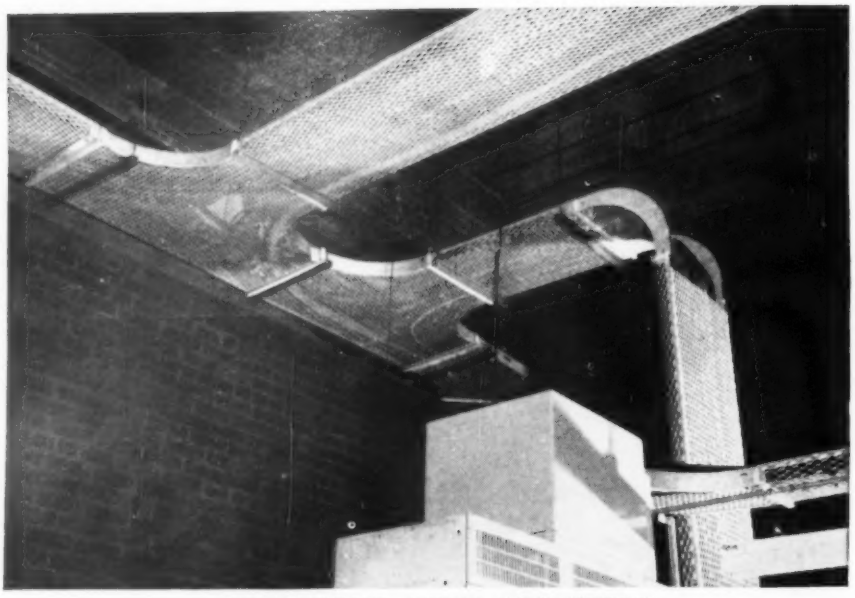


Femco Circuit Scanners may be used for many different control applications. They are low in cost, easy to install with only two wires and are extremely reliable in day in, day out operation.

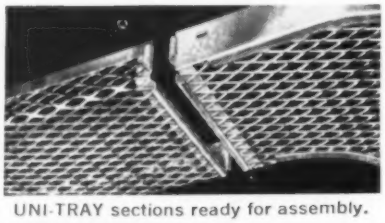
GET THE FACTS—
ASK A FEMCO SALES ENGINEER

UNderhill 3-3200 **Femco, Inc.** IRWIN, PA.

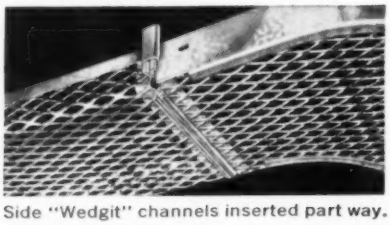
COMMUNICATION • Electronic Engineers • AUTOMATION



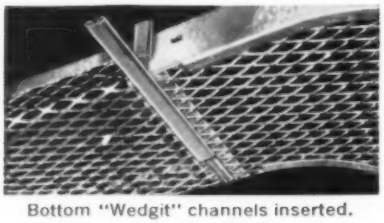
EASY FOUR-STEP ASSEMBLY



UNI-TRAY sections ready for assembly.



Side "Wedgit" channels inserted part way.



Bottom "Wedgit" channels inserted.

Side "Wedgit" driven easily into final position.

CUT INSTALLED COSTS OF CABLEWAYS with this improved UNI-TRAY system

With DELTA-STAR's improved UNI-TRAY cableway systems you reduce installation time as much as 40%. Simply position the trays, then tap in "Wedgit" fittings to connect sections. No bolts, pins, or hinges to fit or tighten. UNI-TRAY joints are assembled four times faster than cableways with other types of fittings.

Strong, lightweight expanded metal sections provide the ventilation necessary for high current rating of cables, prevent collection of water and dirt. And continuous contact area of the "Wedgit" fittings provides an excellent contact for grounding.

Hot-dip galvanized steel or aluminum sections, with aluminum "Wedgit" fittings. A wide variety of shapes and sizes to meet your requirements.

USEFUL UNI-TRAY CATALOG • Ask your Delta-Star representative for this tell-all brochure, or write Dept. 556, Delta-Star Electric Division, H. K. Porter Company, Inc., 2437 Fulton Street, Chicago 12, Illinois. District offices in principal cities.

H. K. PORTER COMPANY, INC.

DELTA-STAR ELECTRIC DIVISION

generation of electricity. Surplus gas available at the Works will be used at the generating station.

Ore for the Works is available about 1000 km to the south, near Asswan where the Lybian desert commences. To mine this ore, which has an Fe-content of roughly 47 per cent, DEMAG has delivered all the equipment and the necessary handling plant to ensure an output of more than 300,000 tons a year.

The necessary supplies of coke are to be secured by imports from the Federal Republic (320,000 tons annually) and other countries.

X-RAY MACHINE WILL INSPECT HEAVY CASTINGS

△ A 24-million volt Betatron has been installed at the New Castle, Pa., plant of Mesta Machine Co. for x-ray inspection of heavy castings. The radiography equipment is located in a building especially designed and constructed with fine aggregate concrete walls measuring six ft thick.

Fast and efficient inspection of massive castings is made possible

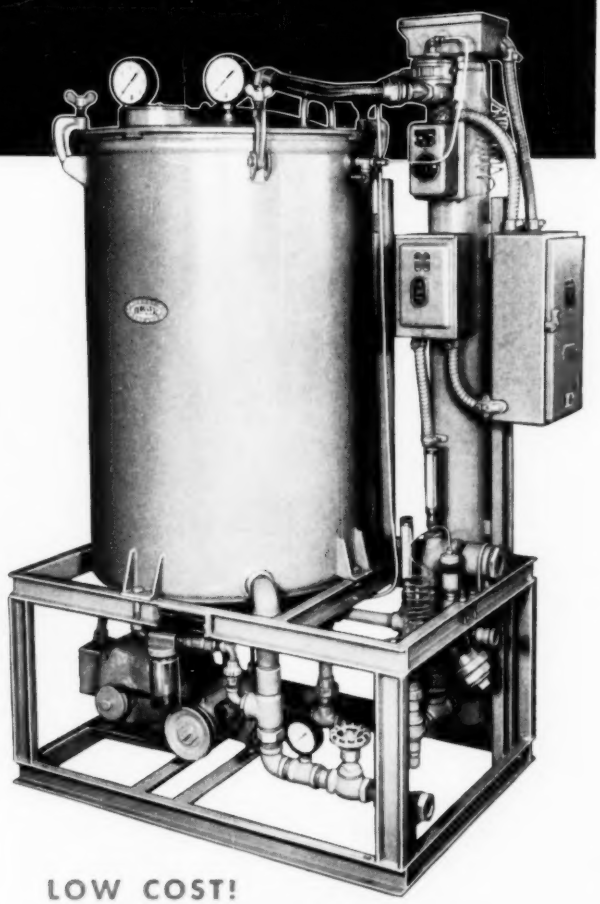
LEADED STEEL

Scene in Bethlehem Steel Co.'s Lackawanna, N. Y., plant Open Hearth Department during production of leaded steel. The plant began making this free-machining steel in bars and billets last March. Bethlehem's carbon screw stock is being marketed under the trade name, "Beth-Led."

FOR COLD MILL BACK UP
ROLL BEARING SYSTEMS...

FIL-THERMO-VAC

OFFERS... a low cost, highly efficient method of removing WATER and DIRT from lube oils.



FIL-THERMO-VAC ADVANTAGES

- Operates on only 3 or 4 turns, compared to 7 or 8 with centrifuge method.
- Improves primary filtration cycle . . . requires cleaning only once a month.
- Requires only part-time operator . . . saves man hours.
- Serves as an excellent emulsion breaker . . . eliminates need for extra equipment.
- Does not remove additives or inhibitors from oil.

Oil disperses through fiberglas micro-filters into vacuum chamber where water and other volatiles are drawn off . . . condensed and ejected.

LOW COST!
Automatic self-policing "package system" costs less, does better job than any other method. It will pay to get the facts!

BOWSER ESTABLISHED 1885

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MARKETING DIVISION—FORT WAYNE, INDIANA

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BOWSER, INC.
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Gentlemen: Please send 12-page Fil-Thermo-Vac folder to:

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Valley ingot moulds are designed for individual steel plant conditions. These moulds meet today's metallurgical requirements

VALLEY MOULD AND IRON CORPORATION

GENERAL OFFICES: HUBBARD, OHIO

Western Office: Chicago, Illinois. Northern Office: Cleveland, Ohio

by the design of the unusual concrete building housing the x-ray equipment. Special platform cars supporting the castings can be joined together to form an electrically-driven unit, and moved on tracks at 50 fpm through the open doorway. Mounted on the last car is the immense concrete door, weighing 85 tons, and measuring 13½ ft high, nearly 18 ft wide, and five ft thick. This door forms the closing link in the concrete radiation shield.

The Betatron unit is suspended from a telescoping boom carried on an overhead travelling crane within the Betatron building. This arrangement makes it possible to move the Betatron unit to almost any position required for the x-rays, and eliminates the necessity for shifting the heavy castings once inside the building. The Betatron x-ray machine, built by Allis-Chalmers Manufacturing Co., can inspect castings eight in. thick in only 1½ min, compared to the two days required by x-rays from a radioactive cobalt source.

Operating personnel have access to the enclosure through another door leading to the control panel and film processing facilities. Electrical interlocks on this entrance and the loading entrance cut all power to the x-ray should either door be opened by accident or mistake while the unit is in operation.

ANNOUNCE NAME CHANGE FOR ASKANIA REGULATOR

Δ Expansion of the products and services of a major subsidiary of General Precision Equipment Corp. and a name change to reflect the expansion were announced by Edwin A. Link, president. Effective at once, GPE Controls, Inc., will be the name of the former Askania Regulator Co.

GPE Controls will offer a broader line of engineering services and products for automatic process control to industry through expansion of its own products and services and by integration with certain products and technical services of three other GPE subsidiaries, Mr. Link said. The companies in this group are Librascope, Inc., of Glendale, Cal., Link Aviation, Inc., Binghamton, N. Y., and Kearfott Co., Inc., Little Falls, N. J.

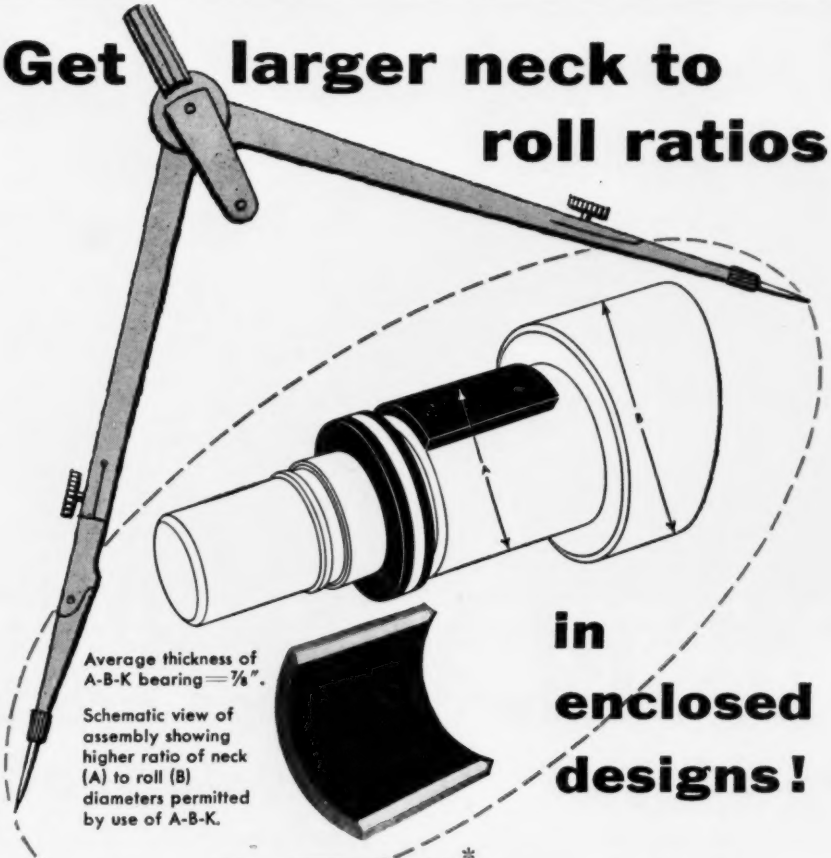
Shand and Jurs Co., another General Precision subsidiary, will continue to serve the petroleum and pipeline industry. Compatibility of the products of Shand and Jurs and of GPE Controls is assured under the new program, Mr. Link said.

Products and services of GPE Controls will include the pneumatic, hydraulic and electro-hydraulic process control systems formerly offered by Askania. In addition, through its liaison with the other GPE subsidiaries, the line will include analog and digital process control computers; data logging equipment; flow computers and integrators; analog-digital converters; and precision mechanical, electronic, and hydraulic components and subsystems.

REFRACTORIES FIRM OPENS BUFFALO OFFICE

Δ Refractory & Insulation Corp. announces the opening of a new office and warehouse at 1660 Kenmore Avenue, Buffalo, N. Y.

Get larger neck to roll ratios in enclosed designs!


Average thickness of A-B-K bearing = ⅞".
Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A·B·K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A·B·K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

American Brake Shoe Company
AMERICAN BRAKEBLOK DIVISION
P. O. BOX 21, BIRMINGHAM, MICHIGAN

Sixty-ton Bedford Crane with air-conditioned cab in the new melt shop of The Timken Roller Bearing Co., Canton, Ohio. Working directly over the severe flash heat of top charging electric furnaces, it positions and dumps approximately 40 tons of scrap per swing.

Bedford Cranes are backed by 56 years of specialized experience

Proof of the superiority of Bedford Cranes is found in the high percentage of *repeat orders* from important owners through the years.

In steel mills, power plants, and throughout industry . . . wherever superior performance is *expected*, owners enthusiastically recommend Bedford Cranes.

Available in all types and sizes . . . from five tons to 350 tons and up . . . for all kinds of indoor and outdoor services . . . each Bedford Crane is individually engineered and precision built for its specific application.

Built to the most modern standards and backed by more than 50 years of specialized crane building *and utilization* experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

You are invited to consult a Bedford Engineer on your next crane problem . . . with all the facts on the table, we believe you too will make *your* next crane a Bedford.

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Central Station Equipment Company, 2323 Aviation Highway, Tucson, Arizona, Phone MAin 3-2493

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WRITE FOR COMPLETE CATALOGUE DESCRIBING BEDFORD CRANES IN DETAIL

STEEL MILL BEDFORD CRANES

BEDFORD FOUNDRY & MACHINE COMPANY, INC. • BEDFORD, INDIANA

The company, whose main office is in New York city and whose plant is in Port Kennedy, Pa., manufactures a complete line of bonding mortars, castable refractories, fire brick, insulating cements, blankets and block.

Gene Roller will be in charge of the Buffalo office.

DRAVO WILL INSTALL SINTER PLANT HEATERS

Δ Five gas-fired Counterflo warm air space heaters will be installed by Dravo Corp., in a 460-ft long car shed at the new sintering plant of U. S. Steel Corp. at Saxonburg, Pa. The units thaw coal to facilitate unloading from rail cars.

Each of the five heaters will have an output capacity of 1,000,000 Btu/hr. Installed in an inverted position the heaters will discharge heated air into a trench below the car tracks at the rate of 12,500 cu fpm per heater. When thawed the cars will be shunted from the shed to another building for unloading.

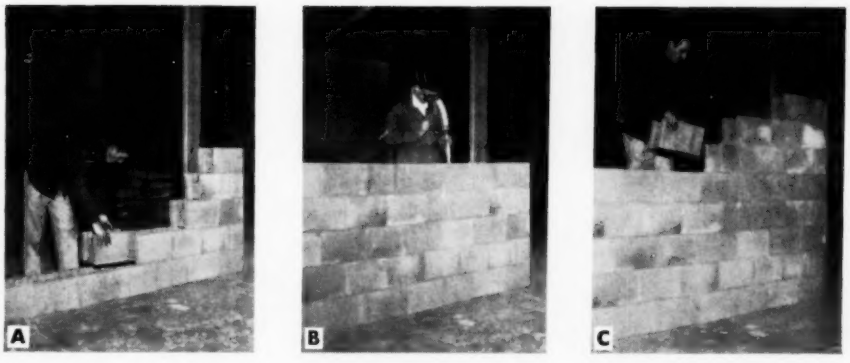
The sintering plant, one of two under construction by Dravo for U. S. Steel, is scheduled to go into operation later this year. Each plant will produce a minimum of 15,000 tons of sinter per day and will be the largest yet constructed in the United States.

JAPANESE COLD MILL SUPPLIED BY MESTA

Δ The Mesta Machine Co. has supplied a 56-in. four-high five stand tandem cold mill to Toyo Kohan Co., Ltd. of Japan. The contract included design and manufacture of the equipment, with installation to be made at the company's Kudamatsu Works. Equipment furnished includes five cold mill stands in tandem, a tension reel with elevating stripper, roll coolant system, and strip and machinery lubricating systems.

The mill will be capable of cold reducing hot rolled carbon steel strip up to 48 in. wide, 0.007 to 0.060 in.-thick, at speeds up to 4500 fpm, and delivering the strip in coils up to a maximum of 33,000 lb.

Mesta is responsible for the design and manufacture of the mechanical equipment, and will provide supervision of the installation.

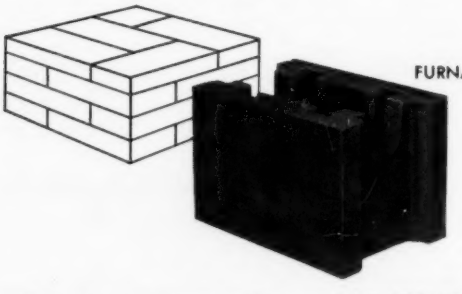


A First 5 courses of FURNACE BLOK are laid in normal pattern. **B** Moldit Castable is poured into openings in the top course of BLOK. Castable flows smoothly down and to the right and left, filling and bonding all the BLOK. No individual bonding of the BLOK is required. **C** The second 5 courses of BLOK are then laid on top of the first. These are filled and bonded as before. This is repeated until the desired height is obtained. BLOK may be cut with a masonry saw. Standard Half Blok and End Blok for corners are available.

. . . significant advance in modern refractory construction . . . monolithic walls and arches *without forms* . . . unbelievable time and labor saving—simplified construction

FURNACE BLOK*

*Patent applied for



FURNACE BLOK (9 x 13½ x 13½) EQUALS THE VOLUME OF 16 FIREBRICK.

It is possible for two men to lay and fill 120 FURNACE BLOK in one hour, or 960 per 8-hour day. Since one large BLOK equals 16 standard 9" brick, this is the equivalent of 15,360 brick laid per day, or 7,680 brick per man-day.

The average bricklayer can lay 500 9" brick per day. This means that FURNACE BLOK construction can be set up 7,680/500 or 15 times as fast.

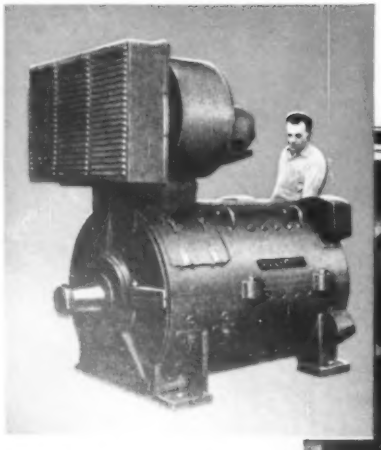
REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

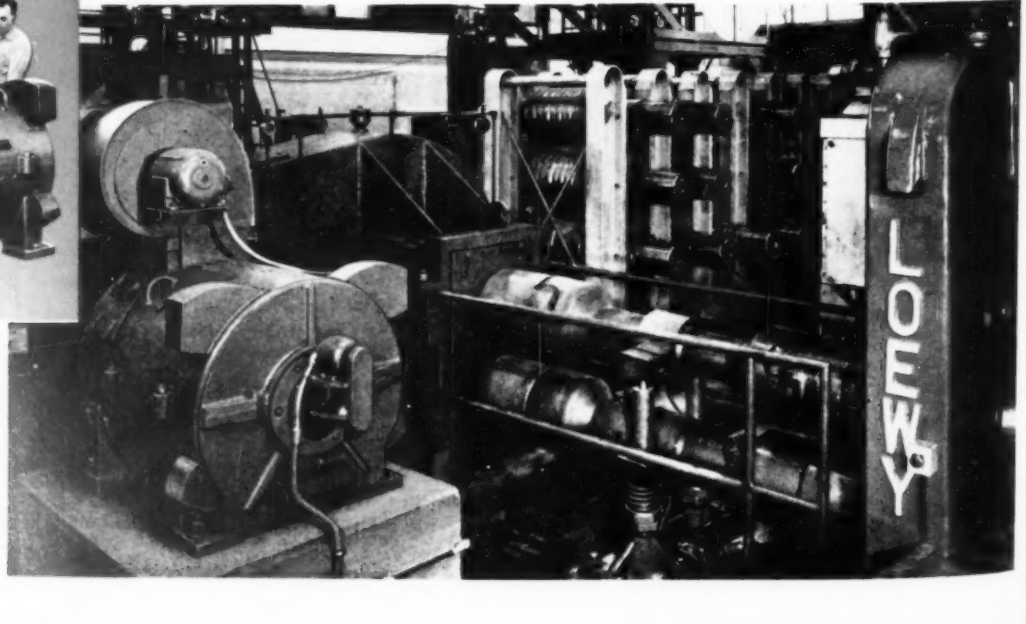
136 WALL STREET • NEW YORK 5, N. Y.

ELLIOTT C-W 620 FRAME MOTOR



The Elliott 620 frame mill motor (above) in protected, forced-ventilated enclosure.

This Elliott C-W 620 frame motor (below) with a continuous rating of 350 hp, drives a two-high reversing mill. Enclosure is protected, forced-ventilated. Note ready access to commutator, even with top-mounted blower. Air vents are screened.



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For 54 years...

Elliott Mill Motors have served the nation's leading metal producers

ELLIOTT'S NEWEST MILL MOTOR

delivers greater power . . . greater overload capacity

In 1904, Crocker-Wheeler introduced the *first* "Mill-type" motor . . . insulated with asbestos and mica . . . "bull strong." In the succeeding 50 years, C-W repeatedly introduced bigger, tougher mill motors to keep pace with the steel industry's needs.

Today the Elliott C-W 620 Frame Mill motor extends the 600 series into the higher ratings required for bigger jobs. Rolled steel frame is horizontally split and all connections between top and bottom coils are brought out *external* to the motor. Windings are silicone insulated . . . entirely Class H . . . for longer life under extreme service conditions. Low inertia armature permits quick acceleration and deceleration. Tough and rugged, this motor remains especially easy to service and maintain.

More complete information on the 620 frame motor is included in Bulletin PB 9000-2. Bulletin PB 9000-1 covers 600 Frame motors in frames up to the 620.

ELLIOTT Company

CROCKER-WHEELER PLANT, JEANNETTE, PA.

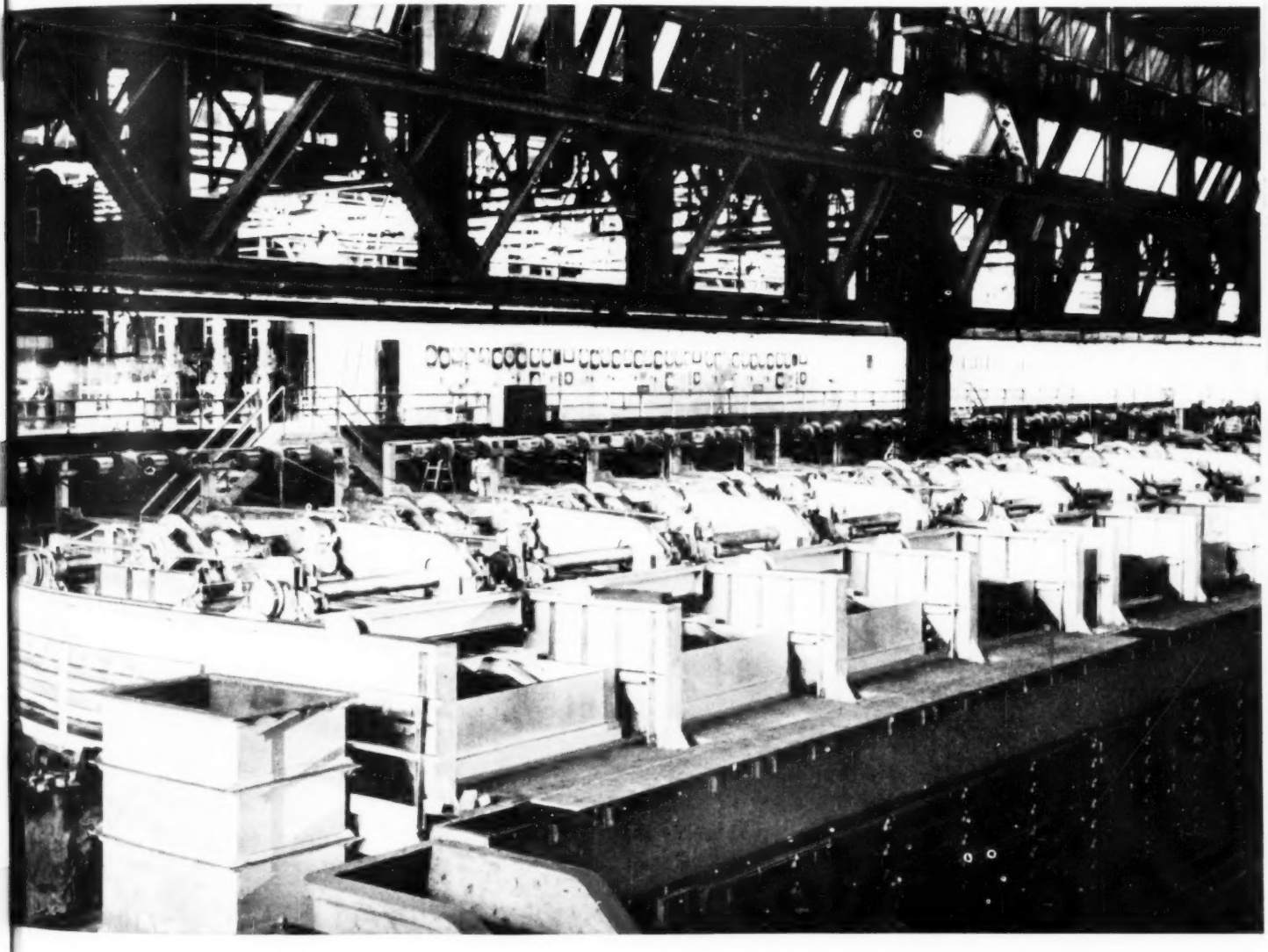
The pit nobody liked...

except our customers

This is of course our one-way fired soaking pit . . . fired from the top.

The location of the burner is only one of the features responsible for its enthusiastic acceptance. Most important however are the 30 years of experience and refinements which we have built into the pit since we first introduced it.

That is why, today, it is the pit everybody respects . . . especially our customers.



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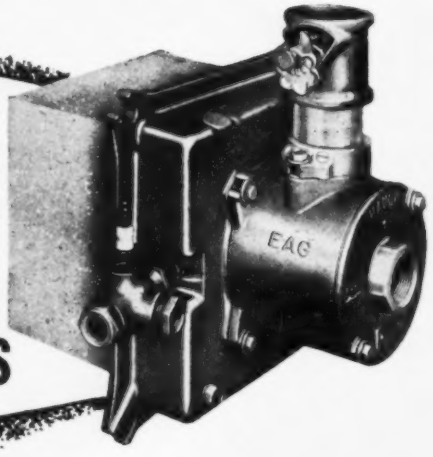
Now... Exceptionally Stable Flame
even with 1000% or More of Excess Air

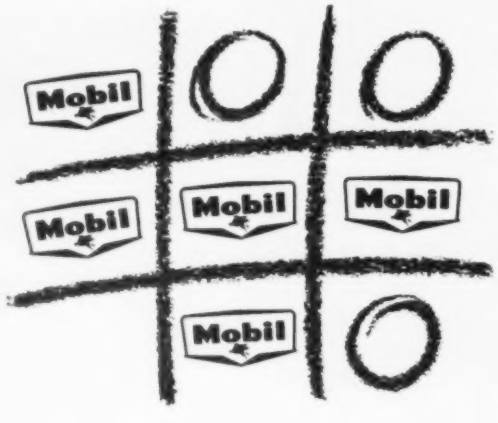
with **New** HAUCK EXCESS AIR GAS BURNERS



- Much higher forward velocity of gases results in better penetration, circulation and distribution of heat.
- Ignition is positive and easy. Flame temperature is easily controlled.
- Burner minimizes stratification of hot gases; eliminates hot spots.
- Fewer burners are required for operation.

This new product of Hauck combustion technology is an important advancement in gas firing for industrial heat processing. Write for Data Sheet No. GB 420LA.

HAUCK MANUFACTURING CO. 114-124 TENTH STREET · BROOKLYN 15, N. Y.
Gas and Oil Burners and Equipment



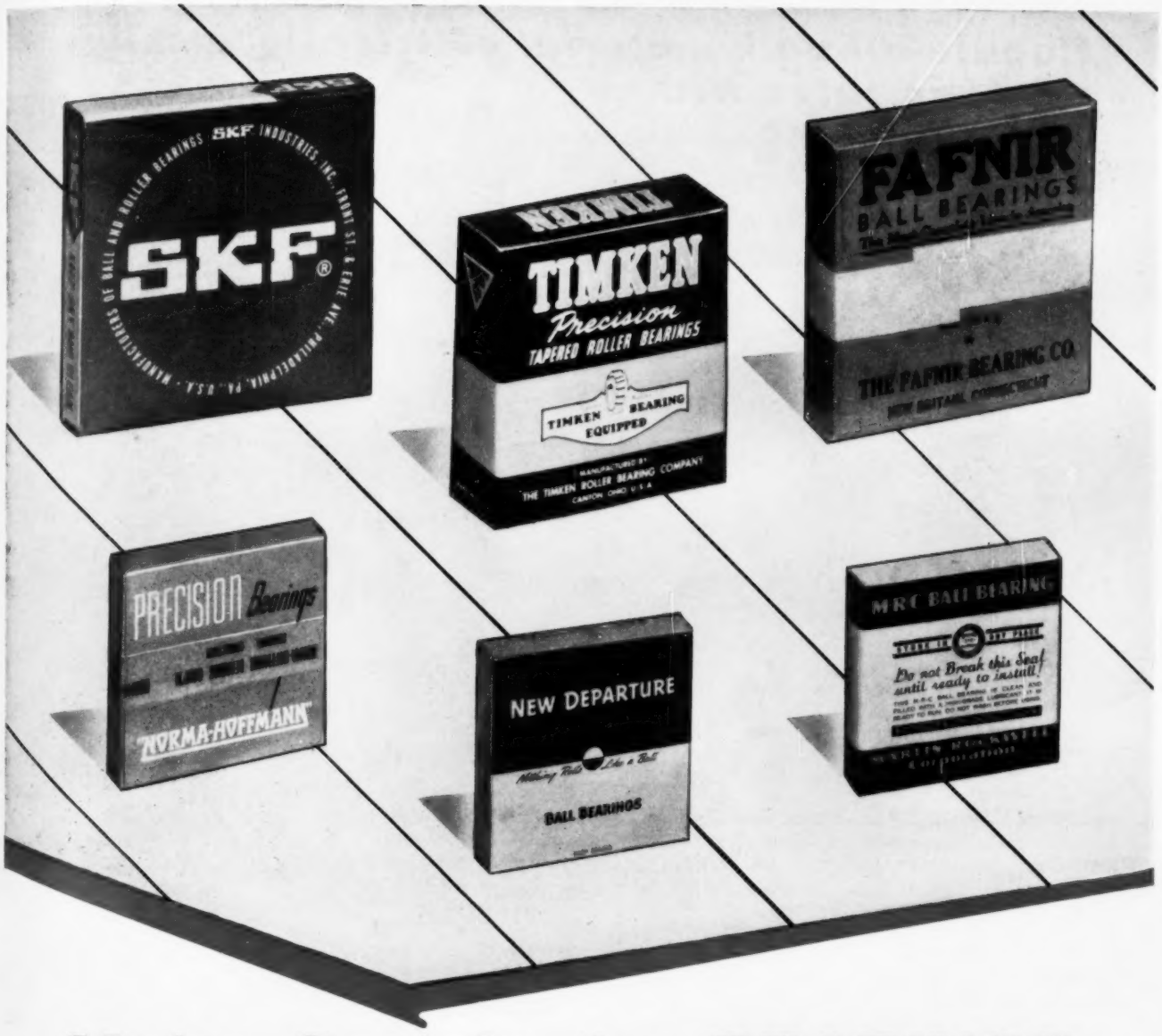
Are you playing Tic-Tac-Toe

with your production costs?

see "Relay Moe" at booth #497

Mobil

Ask about the 10 point Mobil Program for Management



Make Certain the BEARINGS you buy are in the MAKERS' SEALED BOXES

And what is so important about a manufacturer's box? Just this; surplus bearings or shelf worn bearings are usually shipped in one large package. Or, if individually wrapped, in plain boxes—often without any identification, usually of ancient "vintage". . . . and bearings do not improve with age.

Bearings from our stocks are always sold just as they arrive from the manufacturer—fresh, fully protected and guaranteed to be first quality by the maker and ourselves.

We are *authorized* distributors for all of the many lines of bearings and accessories we sell. Our engineers can recommend the best bearing for your application.

Call the branch nearest you.

Providing bearing service in the North →

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
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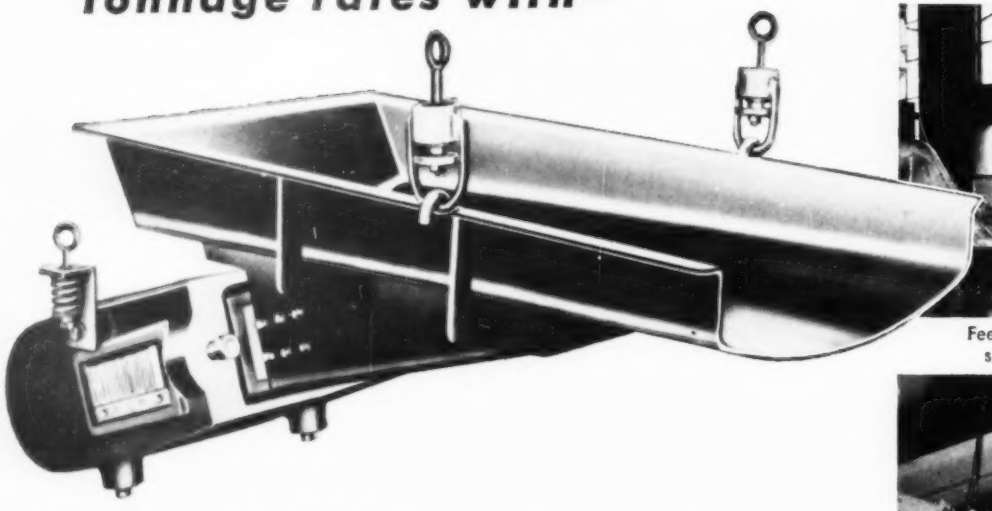
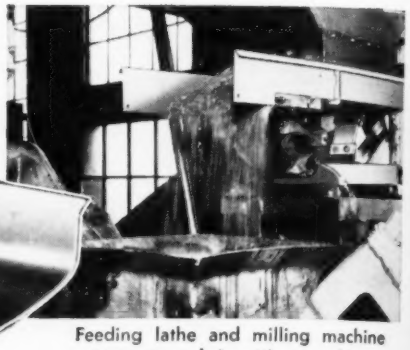
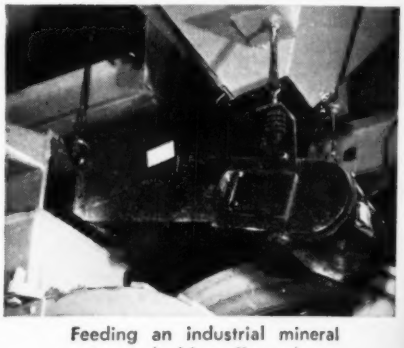
Handle all bulk material efficiently at high tonnage rates with—





Feeding lathe and milling machine scrap to a briquetting machine



Feeding an industrial mineral to a double roll crusher

Feeding metal parts to a continuous heat treating furnace

SYNTRON **"Vibra-Flow"**

VIBRATORY FEEDERS

SYNTRON Vibratory Feeders combine efficiency, dependability and durability to provide controlled rate feeding of bulk materials—fine powder, coal, coke, limestone, ore, etc., hot or cold, dry or damp, to conveyor belts, screens, heat treating furnaces, dryers and other equipment.

SYNTRON Vibratory Feeders are made in a series of single electromagnetic drive models with maximum capacities ranging from 500 pounds to 1,000 tons per hour — and up to 3,000 tons per hour with multi-electromagnetic drive models. All with variable control of feed rate — for operation from 230 or 440 volt, 60 cycle a-c.

SYNTRON Vibratory Feeders can provide the dependable answer to a lot of your bulk materials handling problems. Send details to our application engineers for recommendations and quotations.

Builders of Quality Equipment for more than one third of a century

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designed to increase production, cut production costs, improve products

Vibrators (bins, hoppers, chutes)
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Weigh Feeders
Packers and Jolters
Hopper Feeders
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Rectifiers (Silicon and Selenium)
a-c to d-c Selenium Rectifier Units
Electric Heating Panels
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Electric Hammers
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Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

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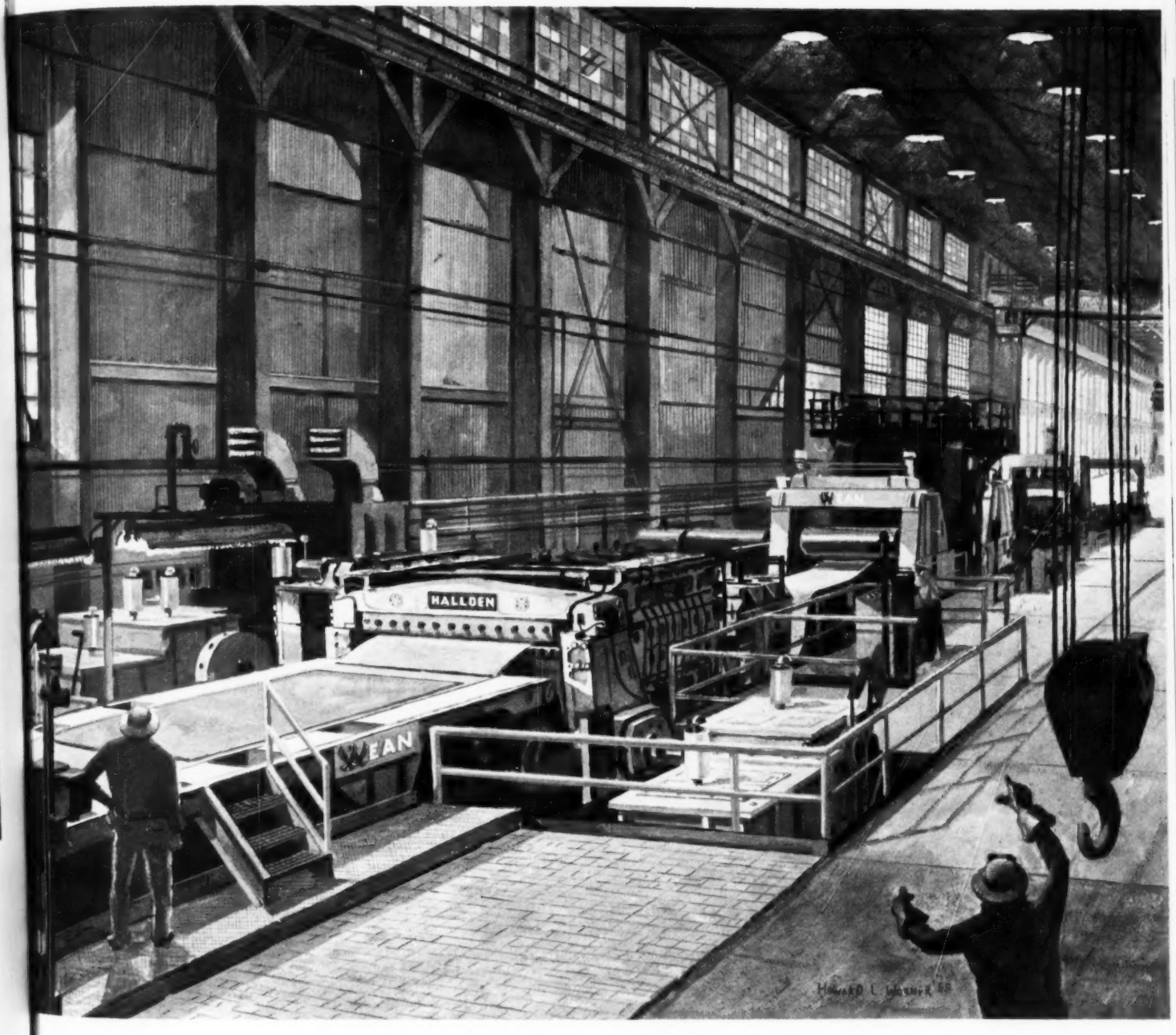
Wean, "J & L" and Shearing . . .

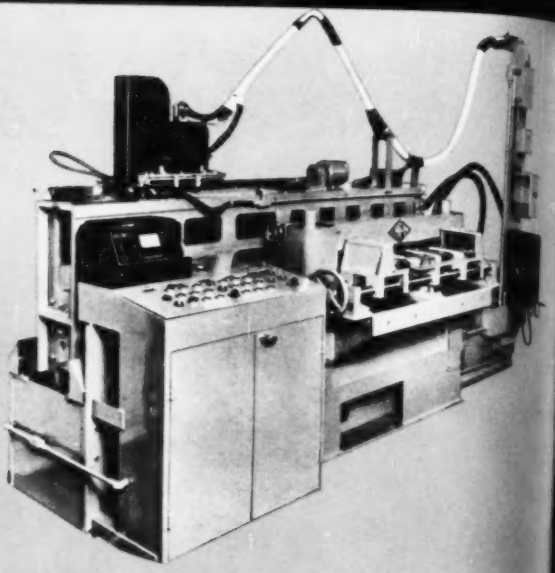


This Wean-Hallden Combination Hot Rolled Shearing Line can best be described as "unique, precise and versatile." Unique . . . since it incorporates a flying shear that will shear strip up to ¼" thick and 74" wide at high speeds with great accuracy. Precise . . . since it is a line engineered of the highest quality components into an automatic production unit of top efficiency. Versatile . . . since its many combinations of shearing, recoiling, slitting, edge trimming and temper passing can produce a great many steel products.

WEAN

THE WEAN ENGINEERING COMPANY INC. • WARREN • OHIO

THE NEW MPM Shear Welder



CONTINUOUS SILICON SHEET PRODUCTION

Shearwelder for coil build up line for 42" wide Silicon Steel from .015" to .030" thick.

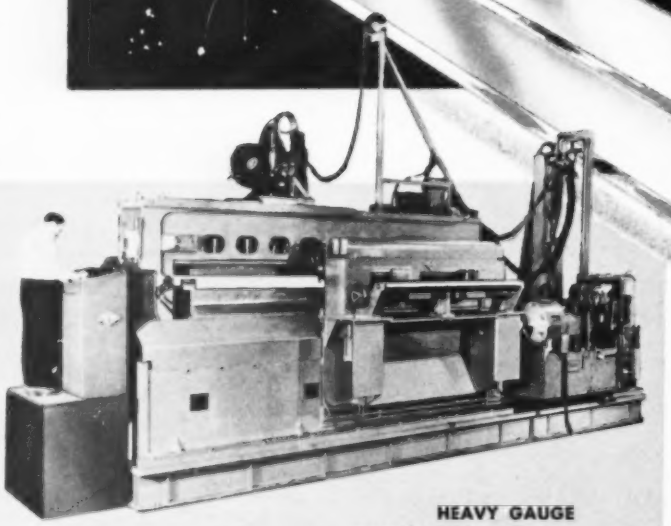
.....more automation for even faster Steel Production!

● Metal Processing Machine Company's new Shearwelders are outstanding because of their advanced design incorporating automatically sequenced operations.

Shearing and welding are performed at the same station with positive clamping right at the work area, thereby insuring perfectly aligned butt welds.

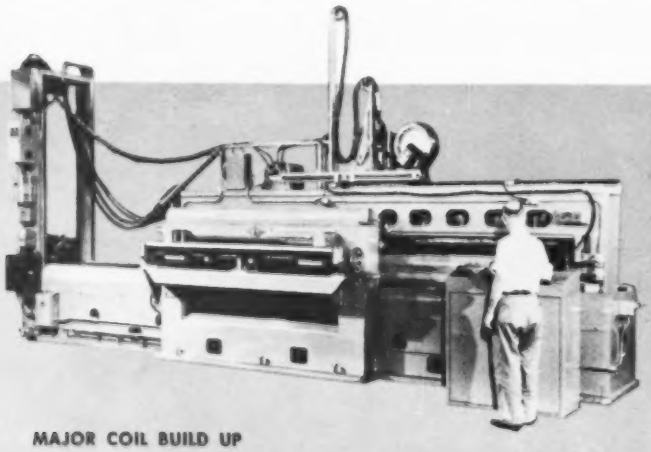
"M.P.M." welds are **extremely ductile,** permitting subsequent rolling, forming, or blanking operations. Weld joints are smooth and require **no trimming.**

Rugged construction is insurance for minimum maintenance and compact design saves floor space.



HEAVY GAUGE STAINLESS PRODUCTION

Shearwelder for butt welding 60" wide x .250" thick Stainless Steel.



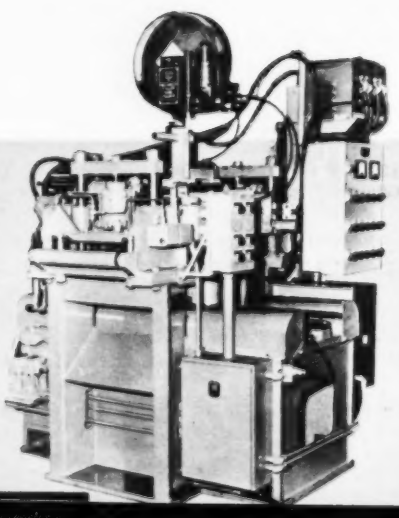
MAJOR COIL BUILD UP

Shearwelder for Carbon Steel coil build up line for .015" to .060" thick x 72" maximum width.

THE METAL PROCESSING MACHINE CO.
SUBSIDIARY OF THE McKAY MACHINE CO.
YOUNGSTOWN, OHIO

McK

MPM

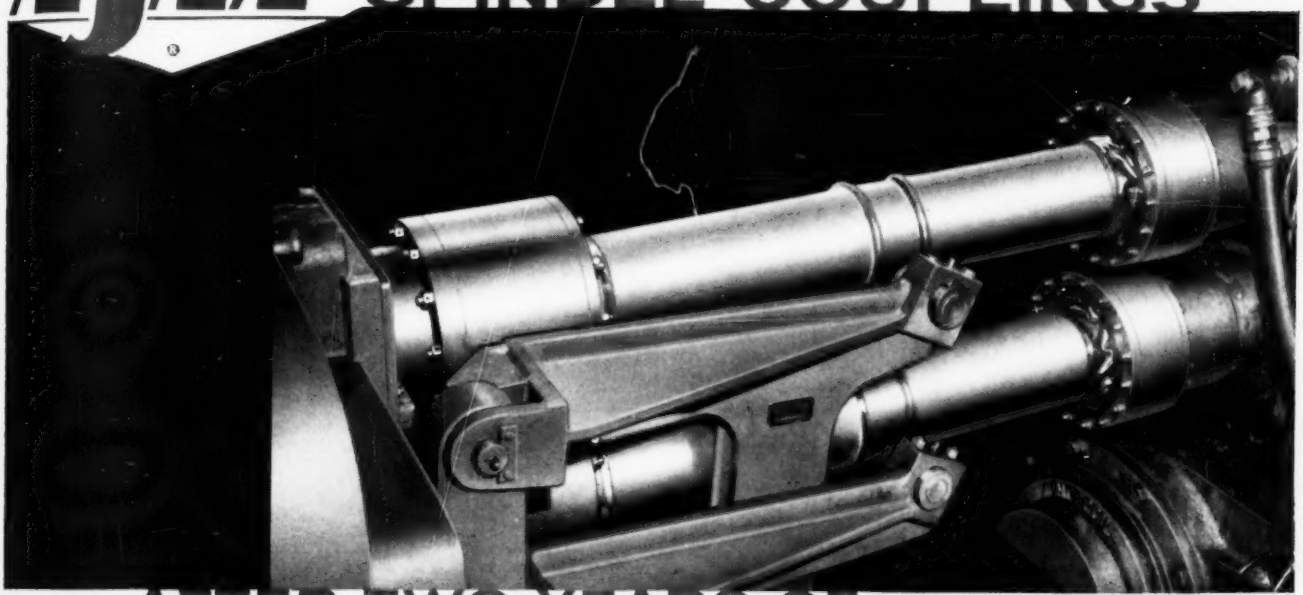


CONTINUOUS TUBE MILL PRODUCTION

Shearwelder used with strip looping device for splicing coil to coil to permit continuous production of tube mill.

10065

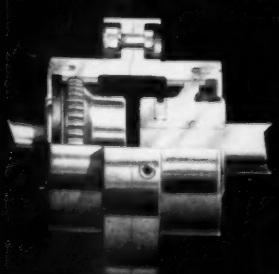
AJAX DIHEDRAL SPINDLE COUPLINGS



AFTER TWO YEARS OF MAINTENANCE-FREE OPERATION

INSPECTION SHOWS COUPLINGS IN EXCELLENT CONDITION

Continuous operation and product quality are important to your production output and costs. Let the performance record, established by AJAX DIHEDRAL SPINDLE COUPLINGS on mills throughout America and foreign countries be your guide in the selection of couplings for your new mills and for modernizing your present equipment.



AJAX DIHEDRAL SPINDLE COUPLINGS use the exclusive AJAX Dihedral tooth design of the popular AJAX DIHEDRAL FLEXIBLE COUPLING shown at left. Peripheral speed remains constant regardless of angular adjustment. AJAX DIHEDRAL COUPLINGS are fully enclosed and eliminate the oil and dirt conditions encountered on universal spindle and slipper joint drives.

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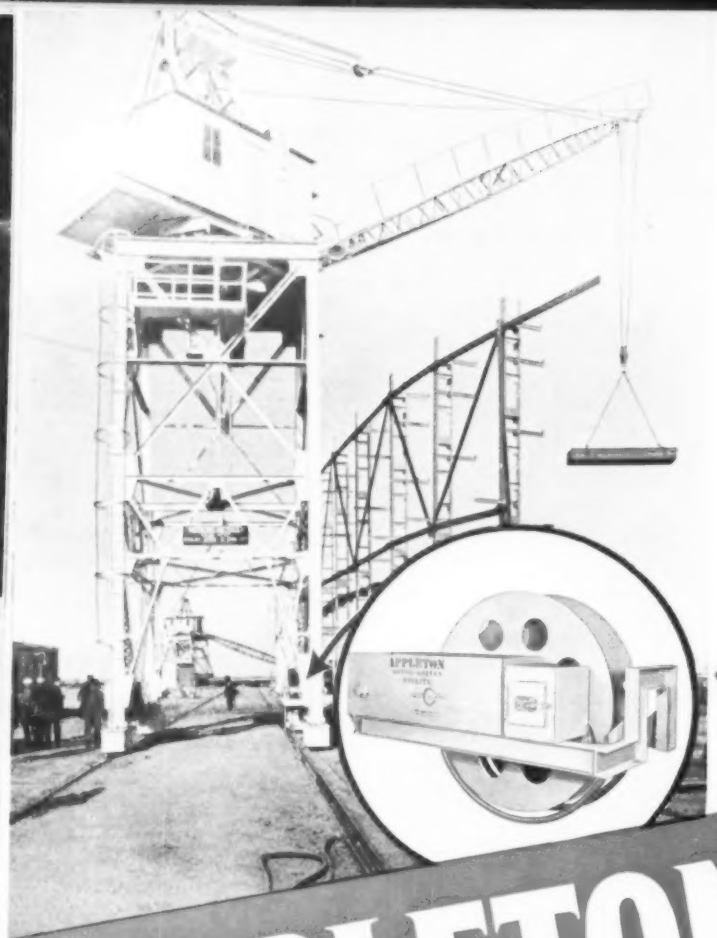
AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N.Y.

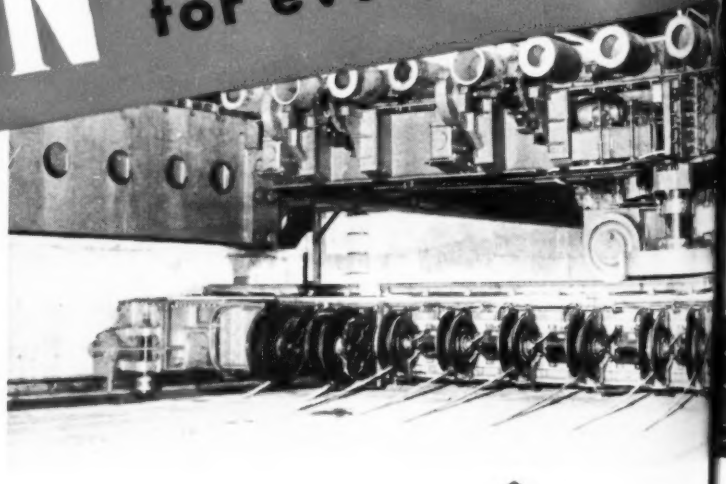


Whether it's for the largest crane or smallest hand lamp, there's an APPLETON *Reelite* to pay out and retract cable with unfailing precision, safety, ease of handling. Made of finest quality materials and to APPLETON-engineered standards of perfection, they are the best you can buy for the purpose. Next time you need a retractable cable mechanism, investigate APPLETON *Reelites* . . . the finest!

Custom designed model Reelites can be developed to fulfill your requirements. As many as 36 conductors can be built into a single compact Reelite. Explosion-proof, weather-proof, vapor-proof . . . air, fluid, torque and tool-balance Reelites are all part of the vast variety of APPLETON reel models. Many Reelites come equipped with clutch or limit switch arrangements built within the unit.

Gantry Crane with special (motor driven) constant duty *Reelite* paying out 500 ft. of 4/0 3-conductor 600 volt Type "W" cable

APPLETON® REELITES* for every purpose



Installation using a custom built Type "EG" constant duty automatic take-up *Reelite* for unloading steel from gondola cars

Battery of 9 various *Reelites* mounted on moveable machine providing a wide variety of individual power leads to this large stamping operation for power and control

Full Information On Request . . . No Obligation

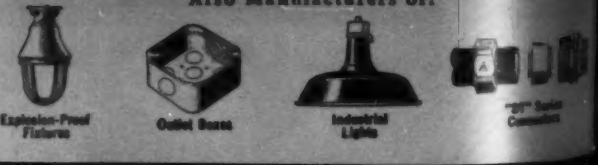
"YS" *Reelite* mounted to pay out cable for roving overhead electric hoist. 335° swivel. Provides maximum flexibility without dangers of snagging, plus elimination of electrical hazards

**Only APPLETON Makes Reelites*

APPLETON ELECTRIC - PRODUCTS®

APPLETON ELECTRIC COMPANY
1701 Wellington, Chicago 13, Ill.

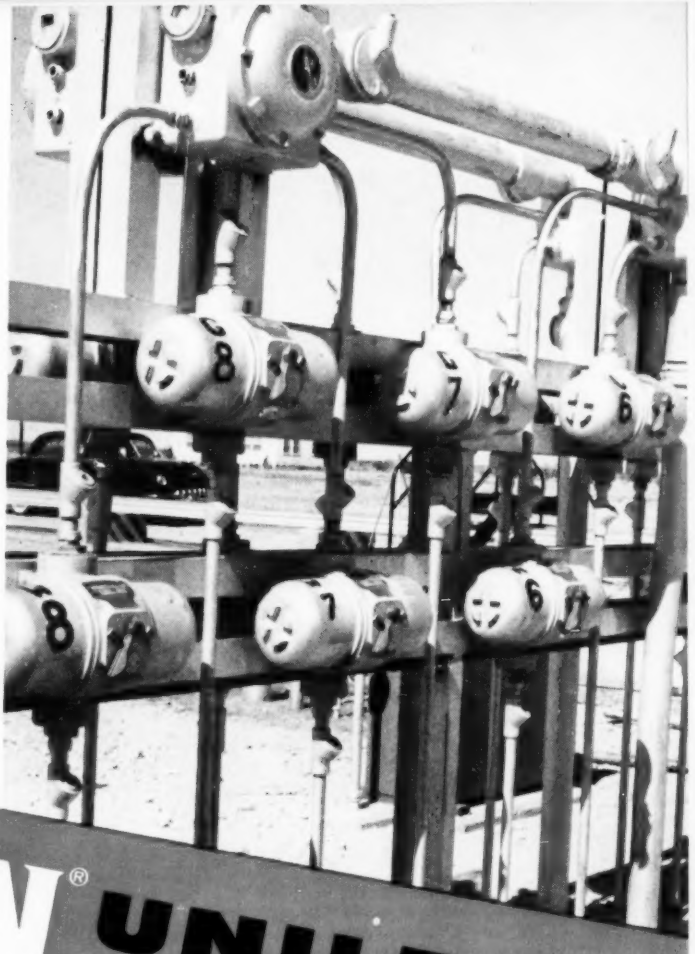
Also Manufacturers of:



Only APPLETON has the capacity to provide you with ALL the *Unilets* you need regardless of size, type arrangement or design . . . Special U.L. Approved explosion-proof, dust-tight and weather-tight models for industrial areas! Malleable iron construction for greater safety! Special features for fast, easy maintenance work, re-wiring, etc. Large stocks in all sizes for quick availability! Yes, whatever the need, your best source of supply is APPLETON for *Unilets.*

WHY SHOP AROUND?

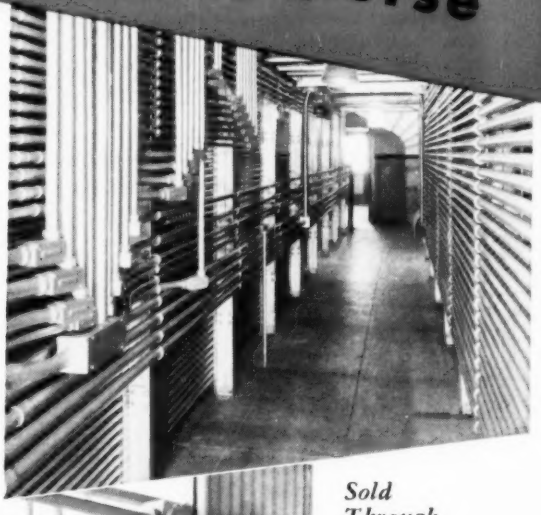
As the illustrations on this page suggest, you can get practically anything needed for wiring or lighting in hazardous or non-hazardous areas from APPLETON. There is no need to "split" orders. Next time you buy, consult APPLETON . . . full information on request.



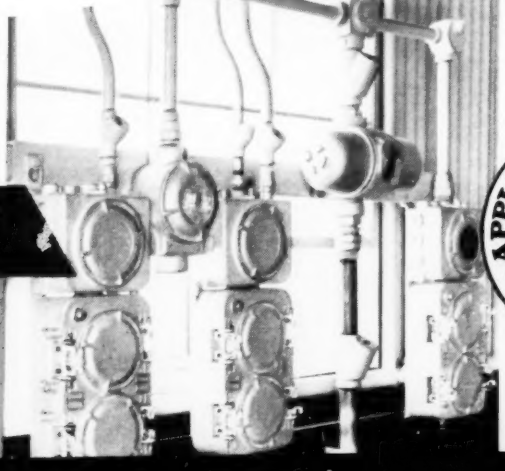
Control panel showing APPLETON *Unilets* in a wide range of styles and sizes in use at main line gas booster station

APPLETON® UNILETS* for every purse

Hazardous area lighting with APPLETON explosion-proof "EFU" type *Unilet* fluorescent lights. All fixtures, hangers, brackets and swivels are APPLETON-designed and built



Hundreds of APPLETON *Unilets* can be seen in this typical generator plant cable room



Display panel board showing close-up view of several types of explosion-proof, weather-tight *Unilets* frequently found in oil refineries, chemical plants, steel mills and many other industrial areas

**Only APPLETON Makes Unilets*

Sold Through Franchised Distributors Only

APPLETON ELECTRIC - PRODUCTS®

APPLETON ELECTRIC COMPANY
1701 Wellington, Chicago 13, Ill.

Also Manufacturers of:

COMPUTER PROGRESS

Digital and Analog Computers at Work

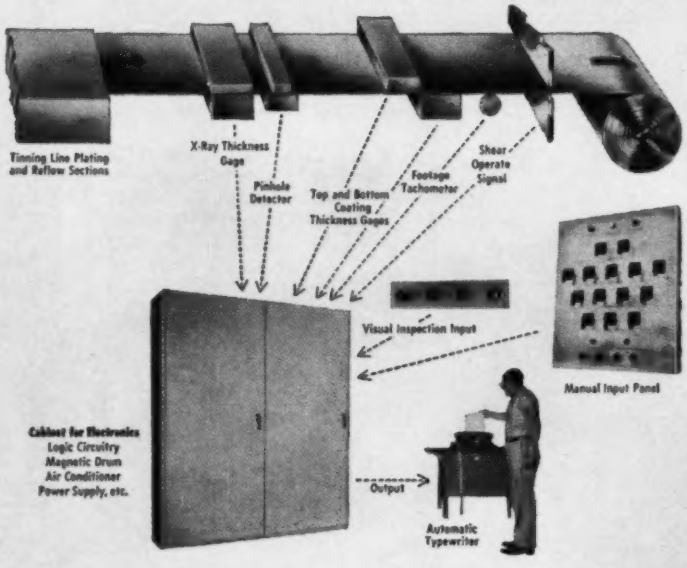
ARTICLE 3 VOLUME 1

SOLVING A TINPLATE INSPECTION AND BILLING PROBLEM WITH MODULAR COMPONENTS

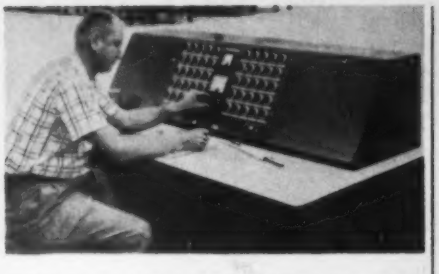
The trend towards purchasing tinplate direct in large coils rather than in sheets brings about a change in inspection techniques. No longer is it possible to separately inspect each sheet; instead, inspection must now be done at line speed on the delivery end of the tinning line. As complete coils of tinplate will now be shipped to the customer, steel companies will need permanent, accurate defect records.

General Electric is now solving this problem for several tinplate producers by *automating* their data logging with the new Model 302 Automatic Inspection Data Accumulator for Tinplate. This system provides a complete, typewritten record for quality control and billing purposes immediately upon completion of each coil.

Unlike many computers installed in factories, the G-E Data Accumulator is designed specifically for an industrial environment, not for office use. Modular electronic units are mounted on strong, 3/16 inch metal frames in completely enclosed cabinets. The all-transistorized plastic coated printed circuit plug-in cards are easy to repair; maintenance costs are reduced since cards may be reused, and spare parts stock is kept small.



In addition, an exclusive new magnetic drum application cuts out approximately 60% of previously required electronic gear. Not only does the reduction in complexity increase reliability, but the space and dollar saving also allows sufficient duplication of circuitry for constant cross-comparison of data. Preventive maintenance can be performed on one section while the other continues to log data. Magnetic storage also eliminates the danger of losing stored data if power fails.



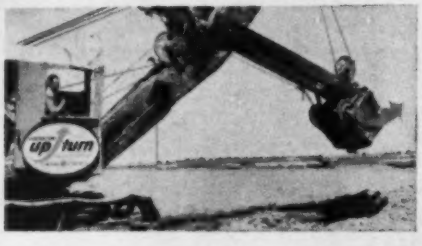
ONLY 8 HOURS INSTRUCTION REQUIRED TO OPERATE PRODUCTION SCHEDULING COMPUTER

The new G-E 306 desk-size analog computer, designed to solve office and factory production and business problems, can be operated by the average clerical worker after only 8 hours instruction.

The computer is used wherever multiplication of a number by each of fifty coefficients and the summing of the results is required. Up to twenty-four such numbers may be multiplied with one setting of dials. Manufacturing problems such as production scheduling, materials explosion and work station load impact studies, as well as business problems like budget syntheses and operating reports (or any other first order linear equation problem) may be solved.

A typical solution takes only 2 minutes. The unit operates on 115 volts.

COMPUTER DEPARTMENT LAUNCHES OPERATION UPTURN WITH NEW MILLION-DOLLAR PLANT IN PHOENIX, ARIZONA



General Manager H. R. Oldfield, Jr., is pictured at the controls of the Operation Upturn steam shovel which recently broke ground for the new 104,000 square foot permanent plant which is expected to be completed by December of 1958.

"Our business is good and getting better," Oldfield said. "We're going to continue to expand during the year, adding perhaps a hundred or more people." The department now has over 800 employees.

The 160 acre site is located in Deer Valley Park, northwest of Phoenix along the west side of the Black Canyon Highway and south of the intersection with Thunderbird Road.

For more information, contact your nearest General Electric Apparatus Sales Office, or Computer Department-Room 102, General Electric Company, 1103 No. Central Avenue, Phoenix, Ariz.

CPA-1

Progress Is Our Most Important Product

GENERAL ELECTRIC

Personnel News...

Admiral Ben Moreell, chairman of the board, Jones & Laughlin Steel Corp., will retire September 30. He will continue as a director and a member of the executive committee of the board of directors. On the recommendation of Admiral Moreell, the board elected **Avery C. Adams,** J&L president, to succeed to the office of chairman of the board on October 1. Mr. Adams will retain the offices of president and chief executive officer.

Admiral Moreell has served J&L as chairman of the board, president and chief executive officer from March, 1947, to February, 1952; as chairman of the board and chief executive officer until October, 1957, and as chairman of the board since the latter date. Mr. Adams came to J&L as president in October, 1956, and assumed the additional duties of chief executive officer a year later.

Julius H. Strassburger has been appointed to the newly-created position of director of research and development of National Steel Corp. Previously, Mr. Strassburger had been assistant vice president—engineering of National Steel. In his new post, he will be in charge of an expanded and co-ordinated program of research and development which will be conducted both on a corporation-wide basis and in the various subsidiary companies of National Steel. Mr. Strassburger first became associated with National Steel as a combustion engineer with the Weirton Steel division in 1924. He continued in this capacity until 1941 when he became manager of the service and maintenance department. He advanced to the position of assistant general superintendent in 1951, to assistant vice president—engineering of Weirton Steel in 1953 and to assistant vice president—engineering of National Steel in 1956.

Joseph J. Barrett has been promoted to superintendent of hot mills by Carpenter Steel of New England, Inc. Mr. Barrett joined the Carpenter Steel Co., at its office and main plant in Reading, Pa., in 1950. He became general foreman in the hot mills in 1951 and general foreman of the company's largest hot rolling mill in 1954. Since December, 1957, he has been assistant superintendent of hot rolling at the Bridgeport plant.

John C. Talbott has been named district industrial engineer for Republic Steel Corp.'s Youngstown plant. He joined Republic in 1937 as a heat-treat helper in the electric weld tube mill. In 1939, he became an industrial engineer and six years later was assigned in that capacity to Republic's Dilworth Porter Division in Pittsburgh. He returned to the Youngstown plant in 1950 as industrial engineer and in 1954 was promoted to assistant district industrial engineer, the position he held until receiving his new assignment.

Paul S. Landis has been appointed manager, production planning at the Pittsburgh Works of Jones & Laughlin Steel Corp. Mr. Landis formerly was assistant manager of the Sheet Mill products Division in J&L's General Office, Pittsburgh. He has been a J&L employee in that position since 1954. He began his career at the Irvin Works of United States Steel Corp., in 1940 becoming chief quality observer. He joined Washington Steel Corp. in 1947 as a sales representative. In 1948 he became associated with the Special Products Division of I-T-E Circuit Breaker Co. The following year he was named manager of New York sales for Worth Steel Co. In 1952 he became manager of plate sales for Colorado Fuel and Iron Corp., a position he held until he joined J&L in 1954 as assistant manager of the Sheet Mill Products Division.

E. H. Dorenbusch, general traffic manager, Armco Steel Corp., has retired after more than 46 years of service with the company. **John N. Lind,** general traffic manager of the National Supply Co., now an Armco subsidiary, becomes director of transportation for the company succeeding Mr. Dorenbusch. **R. W. Kelly,** assistant general traffic manager, has been promoted to general traffic manager of the Armco Division. **William Rehse** has been appointed traffic manager—service, and **D. F. Earhart,** traffic manager—rates, for the Armco Division.

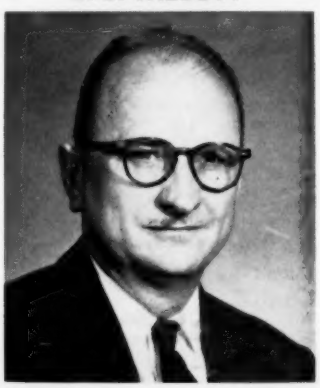
Loren B. Wright was appointed superintendent of open hearths and electric furnaces for Republic Steel Corp.'s Southern District plant at Gadsden, Ala. He

A. C. ADAMS

J. H. STRASSBURGER

J. J. BARRETT

J. C. TALBOTT



L. B. WRIGHT

H. E. JOHNSON

H. J. DEMPSEY, JR.

JAMES MAC GREGOR

succeeds **Jones M. Cahill,** who has retired. Mr. Wright has moved to Gadsden from Lancaster, N. Y., after 10 years of service with the Symington-Gould Corp. where he was superintendent of open hearths and electric furnaces. Previously Mr. Wright spent 11 years at the Inland Steel Co. plant at Indiana Harbor, Ind.

Hugo E. Johnson has been elected president of the American Iron Ore Association. He succeeds **Franklin G. Pardee,** who is retiring. Mr. Johnson, 51, has been with the association since 1954, first as vice president, more recently as vice president-secretary. Between 1948 and 1954, he was assistant manager of the project development group at Battelle Memorial Institute, engaged in research and development programs in raw materials mining and utilization for the iron and steel industry. Previously, he had been with both United States Steel Corp. and Youngstown Sheet & Tube Co.

Harry J. Dempsey, Jr., has been appointed sales manager of Easton Car & Construction Co. Mr. Dempsey was formerly manager—New York District, handling regional and export sales. Mr. Dempsey joined Easton as a sales engineer in 1950. He was successively appointed to the offices of assistant manager, and manager of the New York District.

James MacGregor, formerly president of York Engineering and Construction Co. has joined Aetna-Standard Engineering Co. in the capacity of sales engineer for the pipe and tube mill division. Mr. MacGregor attended Carnegie Institute of Technology and the University of Pittsburgh, and has held various engineering positions with United States Steel Corp. **Charles MacGregor,** formerly vice-president of York, is also associated with Aetna-Standard as a designer.

Adolph O. Schaefer, president, Pencoyd Steel and Forge Corp., has accepted appointment by the Board of Trustees of the American Society for Metals to the unexpired term of secretary of the Society following the recent death of founder-member **William H. Eisenman,** who for forty years had served as national secretary.

Clarence J. Klein, vice president of National Steel Corp. in charge of engineering, retired August 31, but will continue his connection with the company as a consultant. Mr. Klein has been with National Steel since the formation of the corporation in 1929, and was in charge of the development of the plants and facilities including an expansion and modernization program of over $500,000,000 which is just now being completed. Beginning his service with National Steel as chief engineer at the Weirton Steel Co. division, Mr. Klein served in that capacity until his promotion to vice president—engineering of Weirton in 1952. In 1954, he was named vice president for National Steel.

Frank Peterson was appointed manager and **Frank L. Martin** assistant manager of Republic Steel Corp.'s Berger Division in Canton, Ohio. Mr. Peterson succeeds **Paul L. Bruhn,** who was appointed manager of the company's Truscon Steel Division with headquarters in Youngstown, Ohio. Mr. Martin succeeds Mr. Peterson as assistant division manager.

R. A. Bland has been appointed to the recently established post of general sales manager, **E. T. Risan** has been named assistant-to-the-president and **J. E. Martin,** plant manager for Sutton Engineering Co. Mr. Bland was formerly sales manager of the mechanical equipment department. Mr. Risan formerly was manager and Mr. Martin assistant manager of the company plant at Bellefonte, Pa.

Charles B. Cobun has been appointed assistant district representative for Heppenstall Co. in its Pittsburgh sales district. Mr. Cobun joined Heppenstall in 1951 after long association with the United States Steel Corp. He was attached to the Chicago sales district until 1956, when he was appointed manager of ring sales, with headquarters in Indianapolis.

Edward Danielson, Jr., was named regional manager of The Okonite Co.'s newly-created West Coast region. Included in the new territorial division are the Los Angeles, San Francisco, Portland and Seattle sales offices. Mr. Danielson joined the company's San Francisco office in 1947, serving as office manager and district engineer. In 1950, he was named district manager of the Los Angeles office, which post he filled until his recent promotion.

Joseph J. Holtzscher has been promoted to superintendent of the Tin House at the Granite City Steel Co. Mr. Holtzscher had been acting superintendent. He has been with Granite City since 1935.

Clarence C. Simoni has been appointed general manager of Johns-Manville's Packings and Friction Mate-

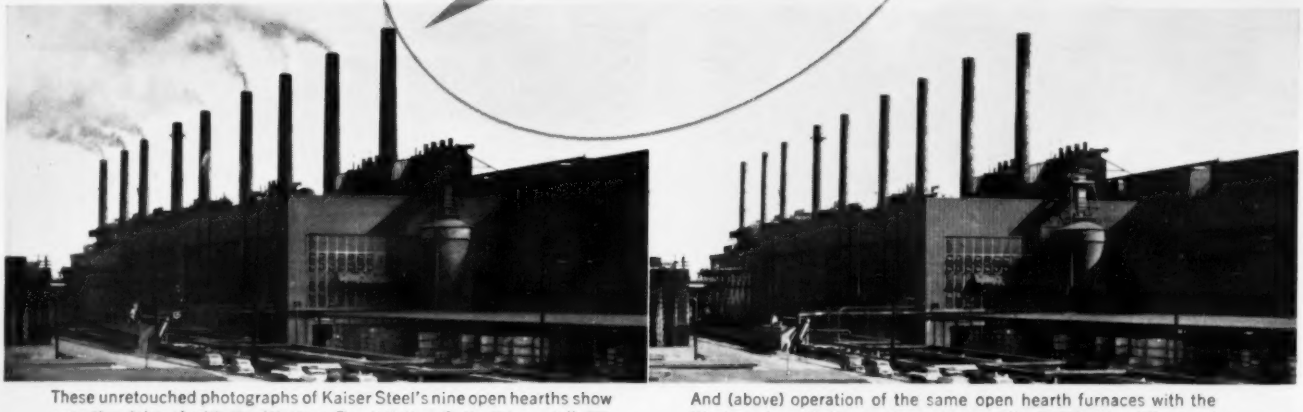
WIDE RANGE OF

WESTERN PRECIPITATION COTTRELLS

DO "AN AMAZING JOB" ON

KAISER STEEL'S

MODERN SMOKE CONTROL PROGRAM



These unretouched photographs of Kaiser Steel's nine open hearths show operation (above) with the Western Precipitation Cottrell turned "off". And (above) operation of the same open hearth furnaces with the Western Precipitation equipment turned "on". Note the difference!

As part of one of the most progressive dust and fume control programs of any steel mill in the United States, Kaiser Steel Company recently placed "on stream" the last of nine Western Precipitation Cottrell Precipitators to control dust and fume from its nine open hearth furnaces. This installation is particularly interesting for several reasons . . .

1. Culmination of a long period of development work by Kaiser Steel and Western Precipitation engineers, this installation marks the first application of Cottrell Precipitators to the unique problems of dust and fume control on hot-metal open hearth furnaces.

2. To handle efficiently the wide fluctuations characteristic of open hearth operations, the units are equipped with Western Precipitation's new "Transistomatic" Controls to insure continuous and automatic voltage adjustment to varying load requirements.

3. These nine Western Precipitation units are ONLY PART of the complete line-up of Western Precipitation equipment installed in this plant. Other Western Precipitation units include BLAST FURNACE PRECIPITATORS for cleaning blast furnace gases . . . DETARRING PRECIPITATORS for cleaning coke oven gases . . . and SPECIALIZED DUST VALVES for simplifying collection operations.

Kaiser Steel states "The very nature of steel production involves furnace heating of large quantities of iron ore, coal, limestone, and other minerals each year. There is no escaping the fact that this activity results in smoke and dust. The Western Precipitation installation . . . represents the result of seven years of research, experimentation, engineering, and construction effort. The equipment does an amazing job."

Naturally, we of Western Precipitation are proud to have played an important role in bringing modern dust and fume control to yet another segment of industry—open hearth steel operations. Our more than a half-century of experience in Cottrell Electrical Precipitator applications throughout the world is at your service. May we study your particular requirements in air pollution control and make helpful recommendations?

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
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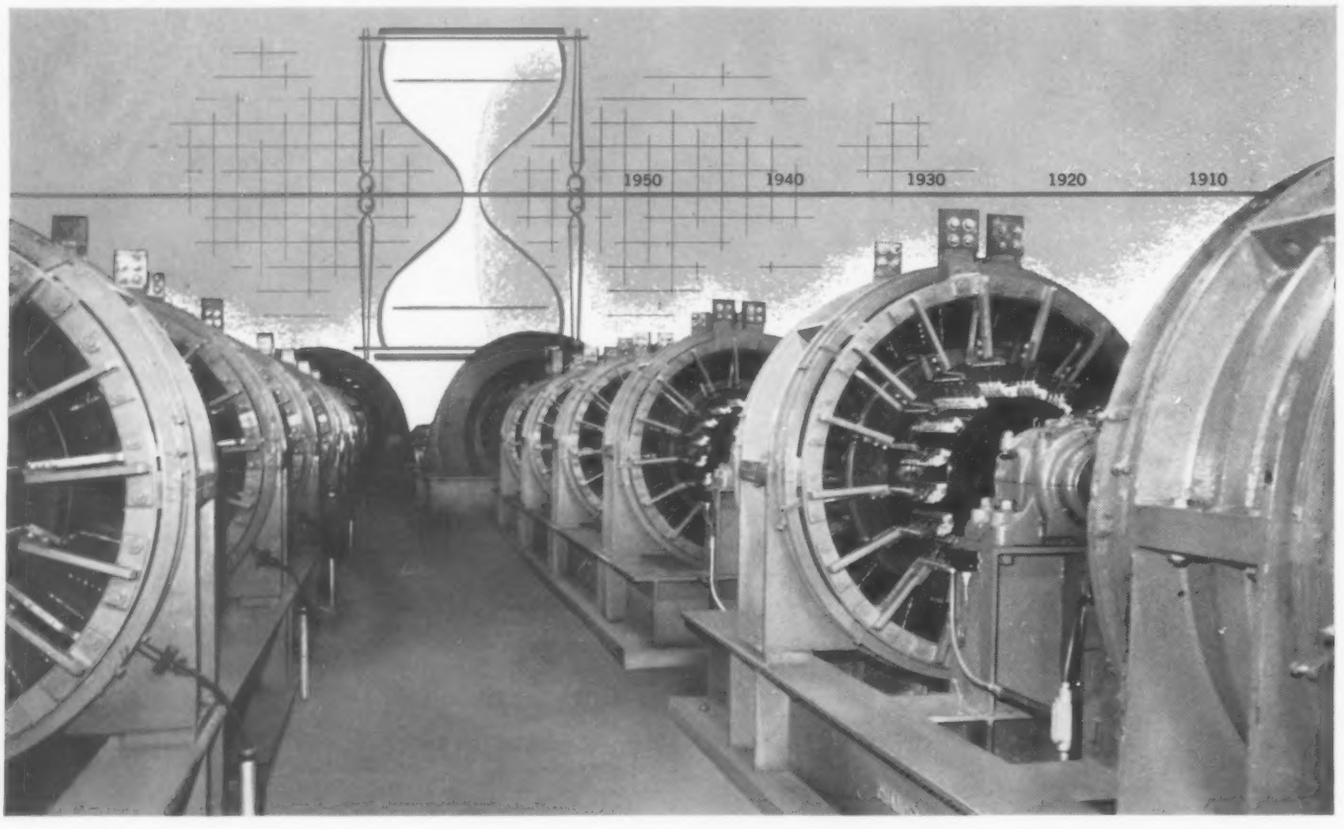

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Chandeysson **generators live 4 times longer—no efficiency drop due to age or overload**

When you buy a Chandeysson Motor Generator, you're investing in lifetime power conversion of highest quality performance, exceptionally low maintenance cost. Year in and year out, Chandeysson M. G. sets keep running steadily, *dependably*. Life expectancy is well over 40 years . . . compared to possibly 10 years for other forms of power conversion equipment. Also, Chandeysson sets give you sustained, lifetime overall efficiency . . . as high as 85% . . . that doesn't decrease with age or overload.

Long life is just one of many reasons why the plating industry *insists* on Chandeysson low-voltage generators for direct current power needs . . . for extra capacity to meet emergencies at the lowest possible cost.

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W. H. HOWARD (left)
W. P. HANKS (center)
R. M. UNDERWOOD (right)

rials Division. Mr. Simoni succeeds **C. B. Burnett,** who was elected executive vice president and a member of the board of directors last November and at the same time temporarily retained the post of general manager of the Packings and Friction Materials Division.

Warren H. Howard has been named sales engineer by Morgan Construction Co., in their Pittsburgh office. Mr. Howard comes to Morgan from the Rectifier Department of General Electric Co., where he was manager of Industrial Sales. Previous positions with General Electric included industrial engineer in the Worcester area and in the Steel Mill Division in Schenectady, N. Y.

William P. Hanks has been appointed Midwest district manager and **Robert M. Underwood,** Northeast district manager of the Cleveland Tramrail Division of the Cleveland Crane & Engineering Co. Mr. Hanks formerly was Southern district manager and has been with Cleveland Tramrail for 32 years. Mr. Underwood was formerly located in California with the Crane Hoist and Engineering Co. in engineering and sales capacities.

George M. Muschamp was named group vice president–engineering, Industrial Products Group, Minneapolis–Honeywell Regulator Co. **O. B. Wilson,** formerly Brown sales vice president, was named group vice president–marketing. **John M. Wilson,** head of design and development, was named director of engineering, relieving Mr. Muschamp of direct responsibility for Brown's engineering department. **R. L. Mallory,** Southwest regional manager, was appointed to the newly created position of sales manager of the Industrial Products Group. In other assignments, **J. A. Robinson,** field sales manager, was appointed sales manager, of

G. M. MUSCHAMP **O. B. WILSON**

Brown Instruments division; **Howard J. MacDonald,** assistant general manager, was made general manager of the Valve Division, and **H. Earl Benson,** senior sales engineer in the Cleveland regional office, becomes sales manager for Rubicon division.

John T. Romano has been elected a vice president of Federal Pacific Electric Co. Previously serving as manager of the firm's Distributor Products Division, Mr. Romano has been with Federal Pacific for thirteen years.

A. E. Carter was elected vice president of manufacturing, Worthington Corp. He succeeds **Leslie C. Ricketts,** who is relinquishing this position in order to devote full time to his increased responsibilities as group vice president of five Worthington operating divisions located in New Jersey and Massachusetts. Mr. Carter joins Worthington from the Ford Motor Co., where he had been manager of the Ford parts plant at Rawsonville, Mich.

Eugene A. Kracker was appointed to plant industrial engineer for Republic Steel Corp.'s Union Drawn Steel Division plant in Massillon, Ohio. Mr. Kracker succeeds **Melvin H. Creter,** who recently was named assistant superintendent of industrial relations for Union Drawn Division. Mr. Kracker started with Union Drawn at the Massillon plant in 1943, as a machine operator in the coil department. Since 1951, he has been a time study engineer at the plant.

John O. Campbell has been appointed Chicago area sales manager for Westinghouse Electric Corp. Apparatus Division. Mr. Campbell was formerly distribution apparatus manager of the central region with headquarters in Pittsburgh.

Obituaries

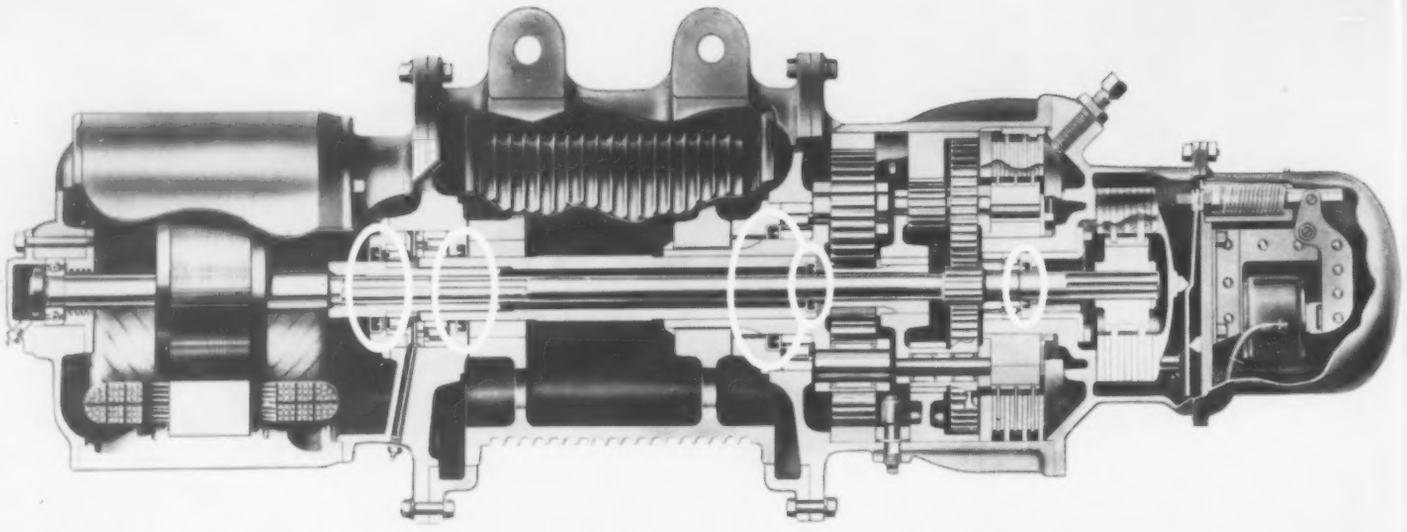
Carl A. Micheltree, 49, erection engineer, Rolling Mill Division, E. W. Bliss, Co., died recently.

William B. Snyder, senior application engineer, Steel Mill Engineering, Systems Application Engineering Division, General Electric Co., died August 10. Mr. Snyder had been active in AISE and steel mill activities for a number of years.

Robert T. Lucas, electrical superintendent, Weirton Steel Co., Division of National Steel Corp., died August 13.

Edward A. Cowles, founder and president of Cowles Tool Co. for 37 years until his retirement in 1954, died August 26. He was 88.

MORE ABOUT THE GARLOCK **2,000**



General-purpose KLOZURE Oil Seals (Model 63 cutaway right) afford complete protection at important bearing locations (circled above) on the Shepard-Niles "Liftabout" Hoist.

Garlock Klozure* Oil Seals

assure durable, dependable performance on tough sealing jobs

Friction and bearing wear, hazardous to any industry, are especially harmful in materials handling. That's why Shepard-Niles and other leading crane and hoist manufacturers specify Garlock KLOZURE Oil Seals for complete bearing protection. Shepard-Niles "Liftabout" is typical of how Garlock KLOZURES not only exclude dust and foreign matter from bearings but also retain the important lubrication—both of which add to greater dependability during rugged hoist operation.

Designing Garlock KLOZURES into your equipment protects bearings with oil seals that are durable, economical, and easy to replace. Garlock KLOZURES can be applied on low, medium, or high speed service. Whether your application is general-purpose in nature, or there's a specific job to be done, Garlock has a KLOZURE design for you.

KLOZURES are another of the Garlock 2,000 . . . two thousand types of packings, gaskets, and seals for every need. The only complete line. It's one reason you get unbiased recommendations from your Garlock representative.

Call him or write for KLOZURE Catalog 20.

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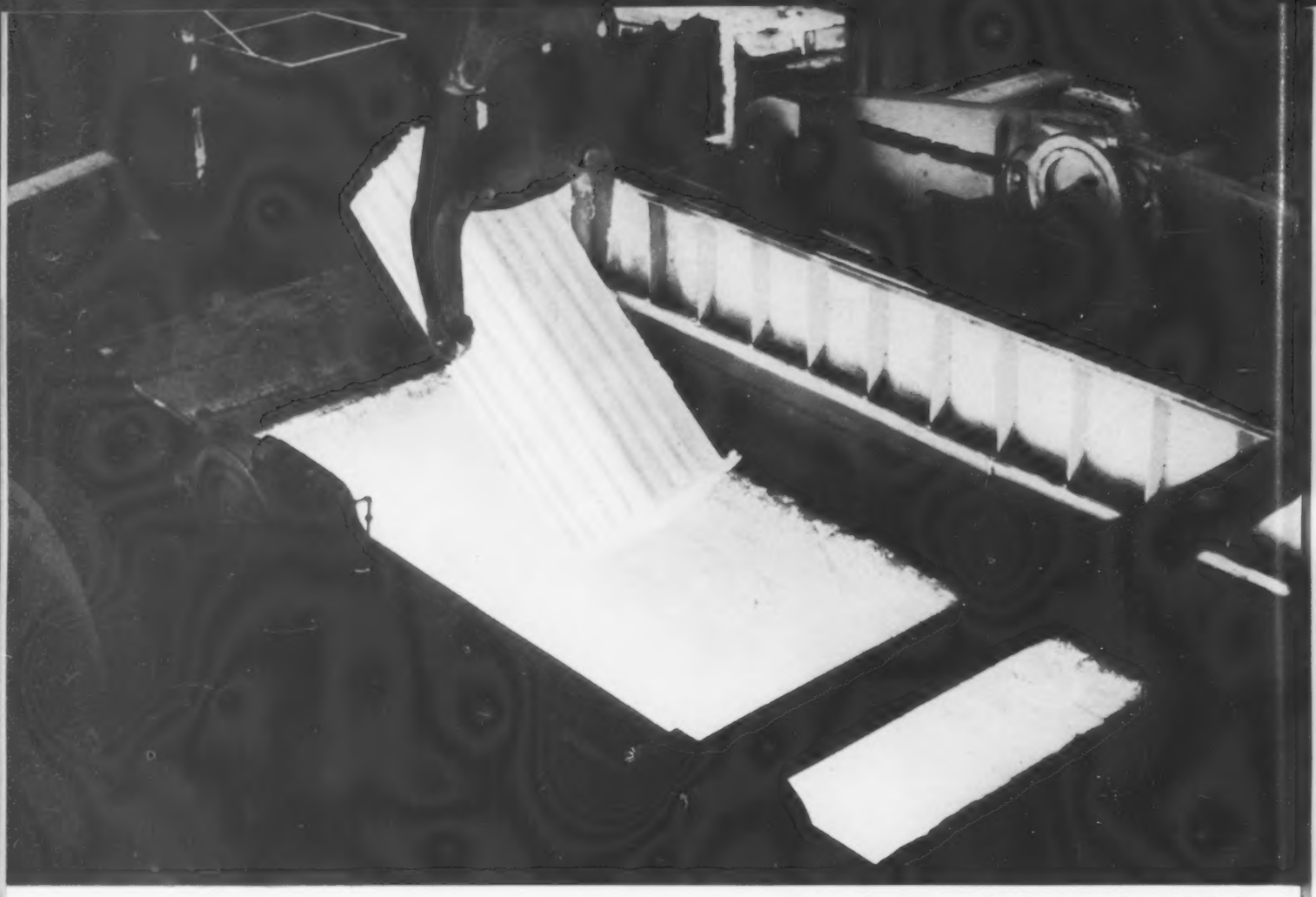
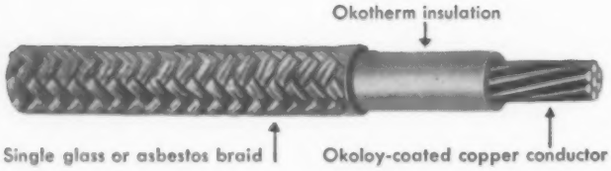

The soaking pit—a typical power and control circuit application for Okotherm-insulated wires and cables.

OKOTHERM . . . a service-proved electrical insulation for high ambient temperatures



Used on overhead cranes in open hearth rooms and around soaking pits, as power feeders, motor, control, and lighting circuits, wherever high temperatures are routine, Okotherm-insulated cables have set amazing records for service life.

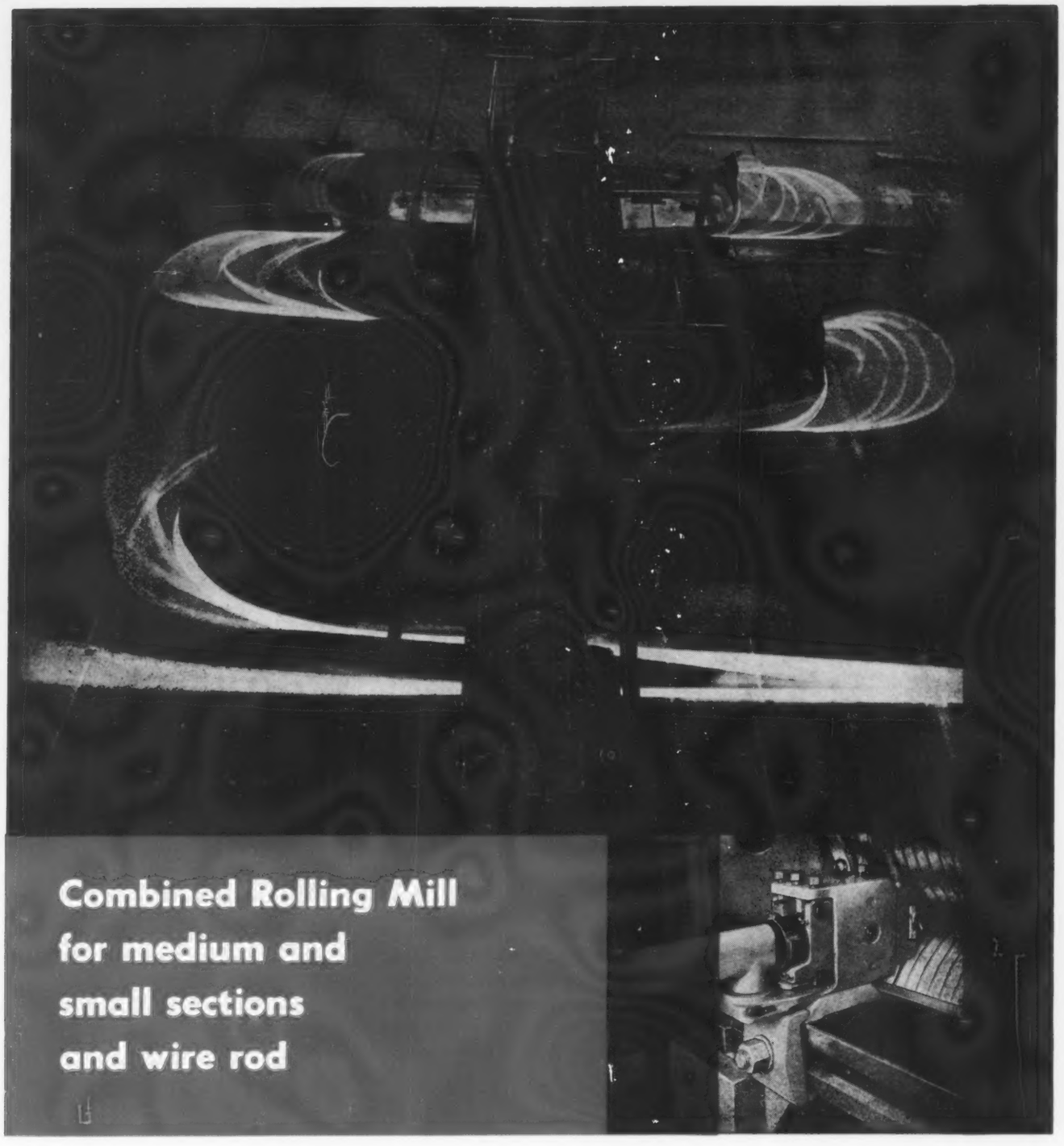
Why? They offer all the characteristics essential for dependable circuit operations in these high temperature locations. Extraordinary heat resistance . . . high temperature compressive strength . . . all-temperature flexibility . . . resistance to ozone . . . high dielectric strength—all these mean greater reliability, longer service in locations too hot for other cable constructions.

Okotherm is a thermosetting insulation compounded of silicone rubber. It is an almost entirely inorganic, Class H insulation that may be used for continuous operation at 150C (as high as 200C under certain conditions).

Okotherm-insulated wires and cables are available with a protective covering of glass, asbestos, orlon or nylon braid; and if required, a seamless aluminum sheath overall. For complete details contact your local Okonite Representative . . . or write for Bulletins IS-2117 and IS-1088. The Okonite Company, Passaic, New Jersey.

4902

where there's electrical power . . . there's **OKONITE CABLE**



Combined Rolling Mill for medium and small sections and wire rod

Roller guide No. 60

Rolling with repeaters in a 19,3—21,6 in. 3-high train of MORGÅRDSHAMMARS combined medium section, small section and wire rod mill.

Our production schedule includes complete mechanical equipment for the combined rolling mill.

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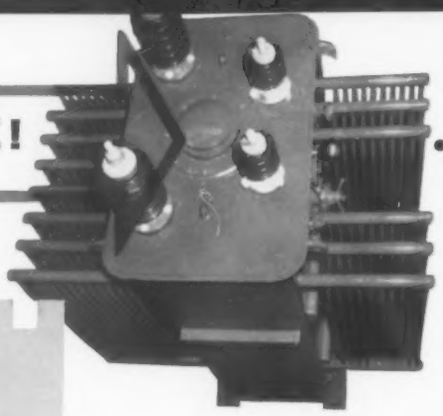

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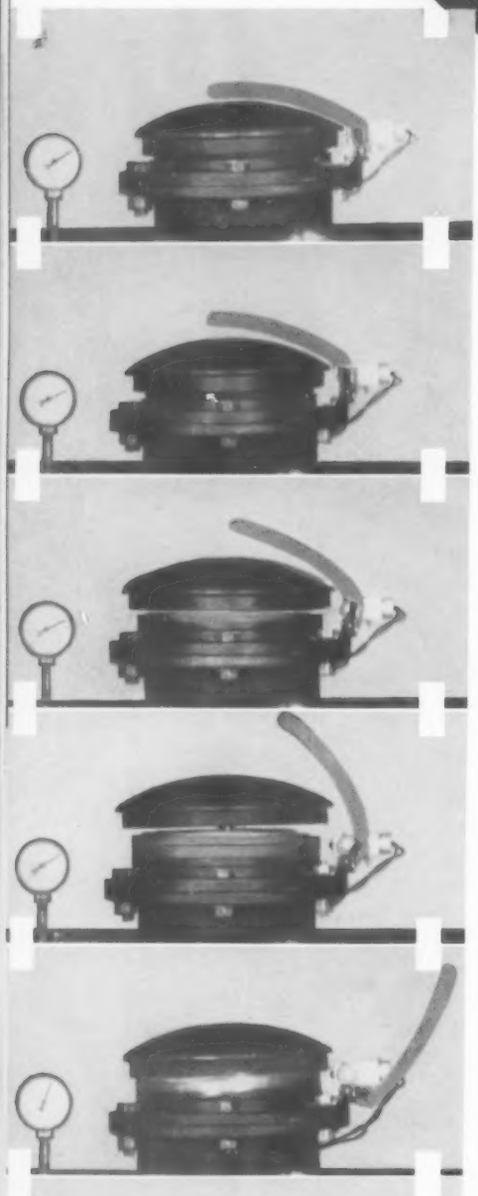
NEW *Positive-acting* PRESSURE-RELIEF DEVICE

- **FULLY AUTOMATIC**
- **SELF-RECLOSING**
- **SELF-RESETTING**



HIGH-SPEED CAMERA SHOWS OPERATING CHARACTERISTICS OF RELIEF DEVICE

These excerpts from a high-speed camera film illustrate both the speed and accuracy with which Pennsylvania's new pressure-relief device operates. In the top frame, 1, the pressure is approaching the predetermined setting (in this case, eleven pounds). In the second frame, the pressure limit has been reached, and the resulting operation is shown in frames 3 and 4. In the bottom frame, 5, the cover is starting to return to the closed position. *The total elapsed time for this sequence was 0.68 seconds.*

The new mechanical pressure-relief device developed by Pennsylvania Transformer engineers is completely automatic. It relieves internal pressure at a predetermined setting by temporarily breaking a gasket seal to permit gas or oil to escape around the cover . . . then *automatically* reseals itself so that the device is again fully effective.

NO PARTS TO REPLACE . . . NO RESETTING NEEDED

By eliminating the glass disc or diaphragm used on ordinary pressure-relief devices, this new Pennsylvania development does away with the time-consuming task of replacing parts. In addition, the need for periodic inspection has been eliminated. There is nothing to break . . . nothing to fall into the transformer . . . nothing to get out of alignment. Highly corrosion-resistant materials are used throughout: anodized aluminum for the cover and flange, and stainless steel for the shaft.

NO BREATHING TAKES PLACE AFTER RELEASE OF PRESSURE

An additional advantage over ordinary pressure-relief mechanisms is that the cover reseals itself while a low positive pressure still exists within the transformer. This definitely prevents breathing. Moisture *cannot* enter the transformer before, during or after the valve has functioned.

Dramatic proof of resealing effectiveness has been obtained from operating tests conducted with the relief device fully submerged in liquid. The inside of the valve remained *free of moisture.*

FULLY TESTED FOR DURABILITY, EFFECTS OF HEAT AND COLD

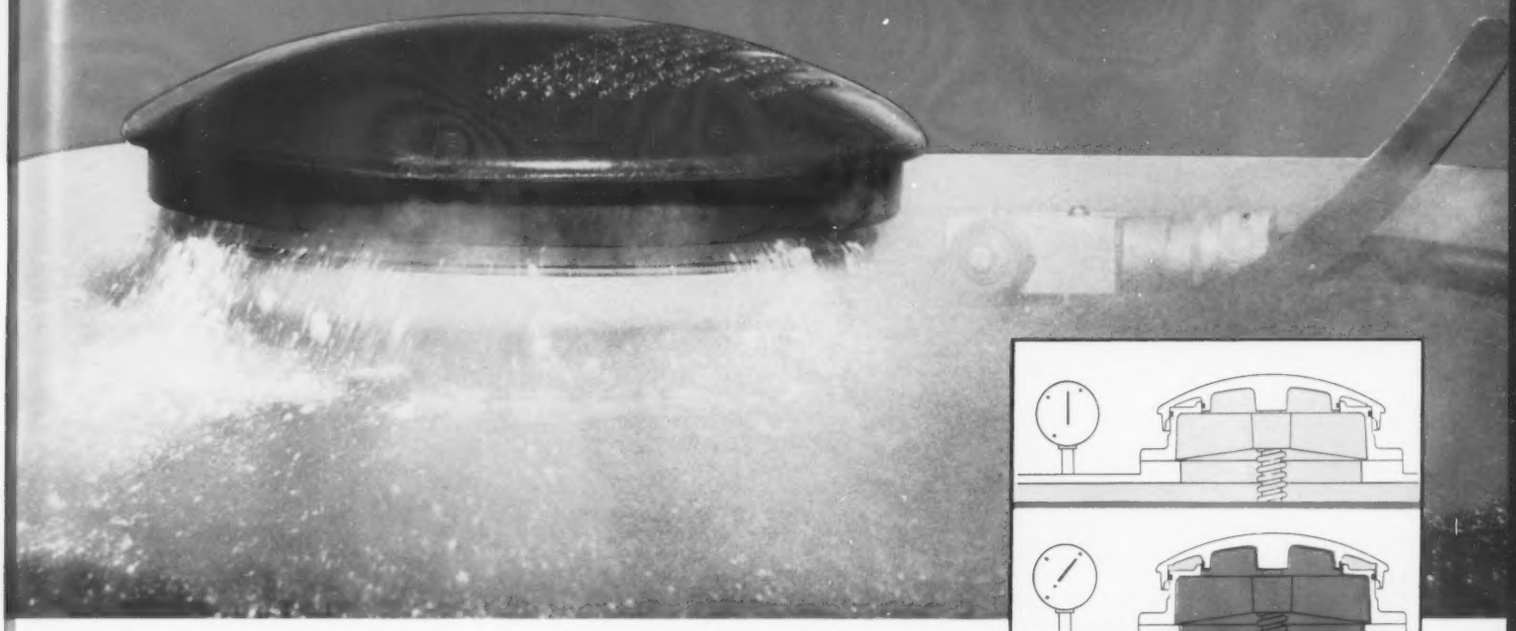
In addition to immersion tests, Pennsylvania's new pressure-relief device has undergone tests for conditions that far exceed any that are likely to be encountered in actual service. These include life tests of as many as *12,000 operations* with standard production

PENNSYLVANIA TRANSFORMER

PENNSYLVANIA

on all Pennsylvania Power Transformers

The pressure-relief device is shown in the closed position (right) and while operating (below). The upward movement of the cover causes the optional signal arm to pivot to an upright position.



models of the valve.

During life tests, the pressure-relief devices were intermittently operated at temperatures as high as 100°C., and also at −15°C. with a heavy formation of ice on the cover. To test the effect of hot oil, valves were immersed in 100°C. oil, with gaskets fully exposed, for as long as 96 hours.

VALVE OPERATES WITHIN ±½ POUND OF PREDETERMINED SETTING

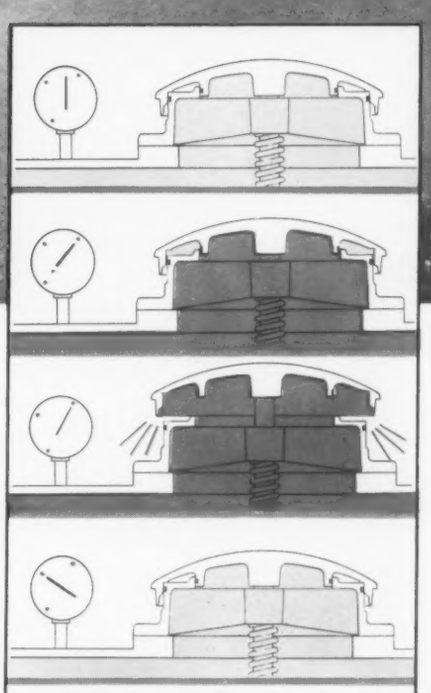
At no time during the foregoing tests did the valves fail to operate within ±10% of the original setting. Following the tests, *all* relief devices were found to be pressure tight.

Pressure-relief devices supplied on Pennsylvania Power Transformers operate within the even closer tolerance of ±½ pound of the predetermined setting. This is assured by standard pretesting of production models. To further safeguard the transformer, the device relieves internal pressure within a split second after the predetermined setting is reached—as shown in the accompanying high-speed camera shots.

OPTIONAL ALARM AND SIGNAL ARM CAN BE RESET FROM GROUND LEVEL

Pennsylvania Transformer's new pressure-relief device is supplied with a combination alarm and signal arm, if requested. The signal arm, which is painted red, is easily seen from ground level when in an upright position. Resetting the signal arm—which can be done from ground level with a hot stick—also resets the alarm.

The new maintenance-free pretested pressure-relief device is available on all Pennsylvania Power Transformers with or without the combination alarm and signal arm. Contact Power Sales Department, Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pennsylvania.



HOW THE PRESSURE-RELIEF DEVICE OPERATES

When the predetermined pressure at which the device is set to operate is exceeded, the spring force acting on the cover is overcome and the pressure, initially confined to the small "primary" area of the relief cover, escapes to the larger "secondary" area. This immediately multiplies the force acting on the cover and lifts it to its full open position, thus allowing the pressure to escape to the atmosphere. The spring force then resets and reseals the device while an internal pressure of approximately five pounds still exists within the transformer.

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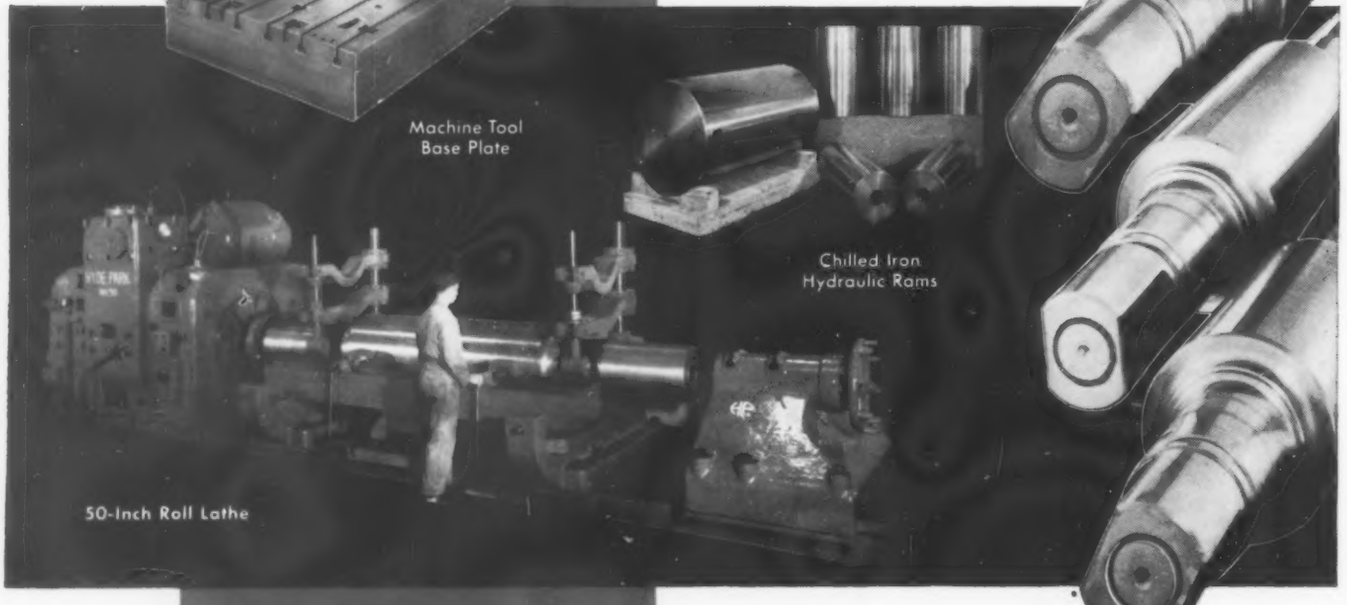

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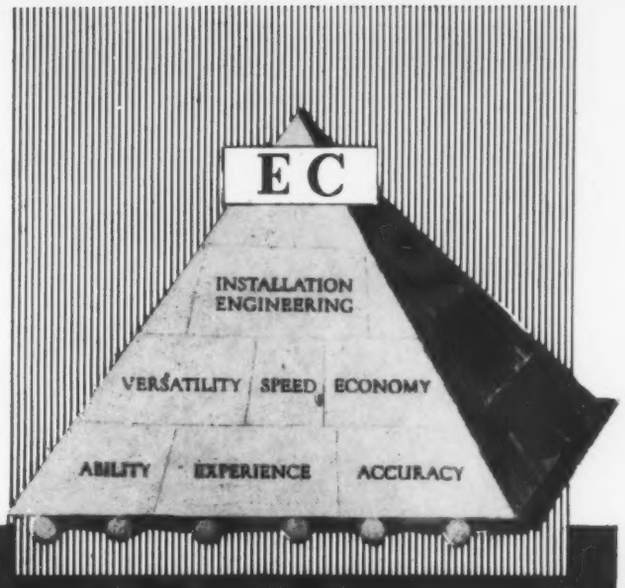

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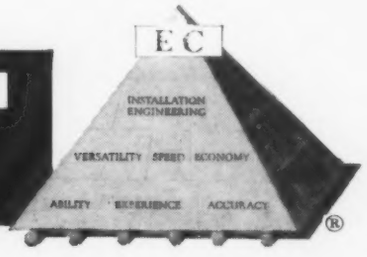

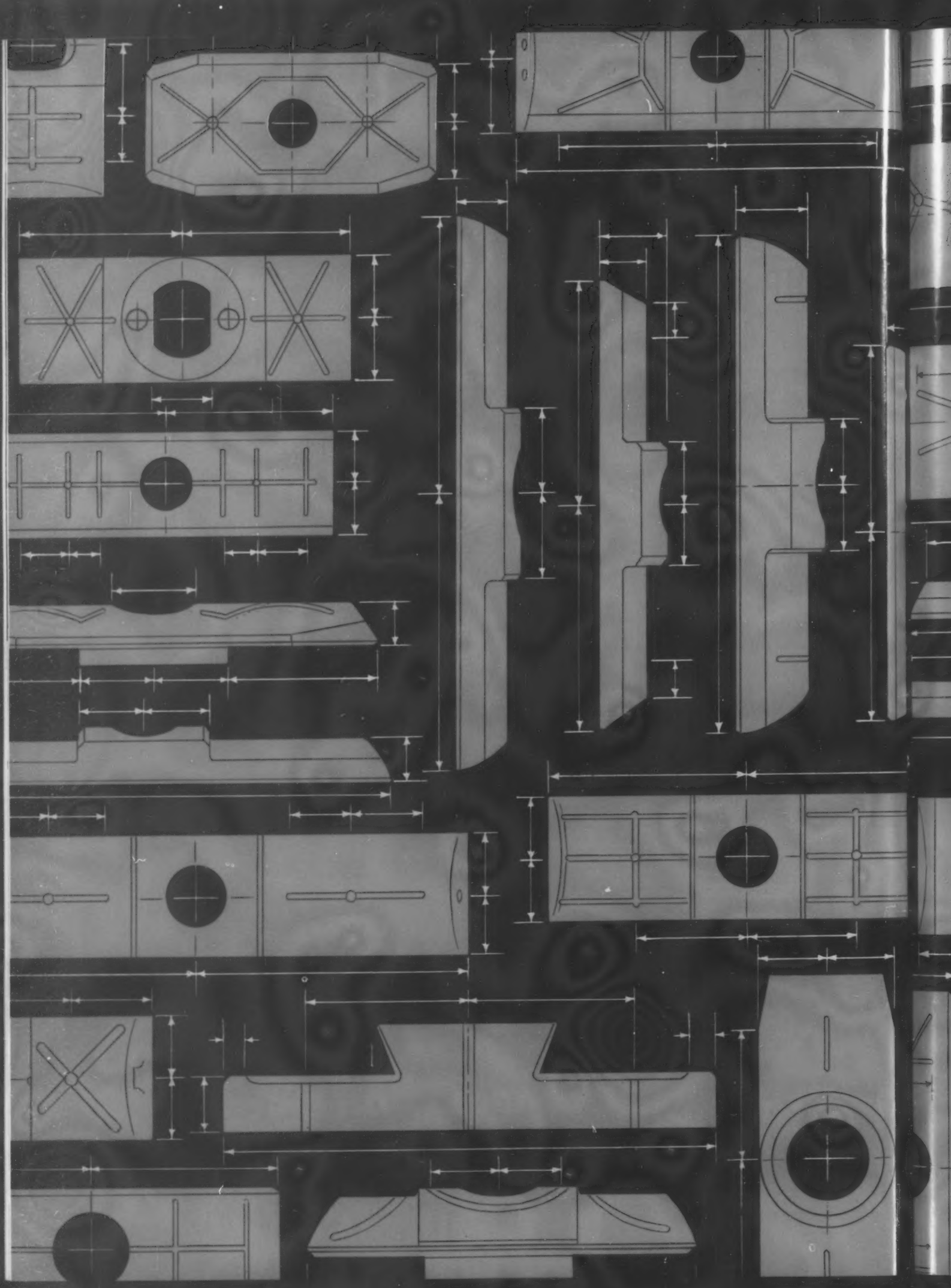

We guarantee that we can cut your rolling mill slipper costs

This is no gimmick offer. It is made with the confidence gained from producing thousands of slippers every year for rolling mills all over the world. If you are not now using NBD slippers on your mills, we guarantee your replacement costs will drop when NBD becomes your supplier.

NBD can do something about (1) *slipper breakage*, (2) *excessive wear*, or (3) *spalling* . . . all can eat high-priced holes in slipper inventories. A change to the proper NBD bronze alloy may be the answer. A tougher more rugged alloy. Or maybe it's a change in heat-treatment that will do it.

Here are other ways we cut your costs:

If it's your policy to buy *rough* castings and machine in your shop, NBD slippers will help you eliminate expensive rejections due to porosity after machining. And you won't be machining off a lot of excess metal—NBD castings are uniform and true to size.

If you like to buy slippers *machined, ready to use*, NBD has facilities for machining all sizes and designs . . . the special tooling that gives you accurate machining at low cost.

If you want *precision cast-to-size* slippers, they are an NBD specialty. In many mills these slippers can be used without any machining at all, or often only a minimum of machining—with corresponding cost reduction. Maybe you can use NBD precision cast slippers.

Improved design can also reduce your costs. Some original slipper designs are unnecessarily elaborate. Many times NBD engineers have saved customers a lot of money by recommending design changes.

So our guarantee is safe for both of us. NBD's spent more than 80 years in the business to make it that way . . . serving every corner of the steel industry . . . making every kind of bronze and copper casting, from slippers to blast furnace cooling equipment . . . making more slippers than any single source.

Today is a good time to take advantage of it . . .

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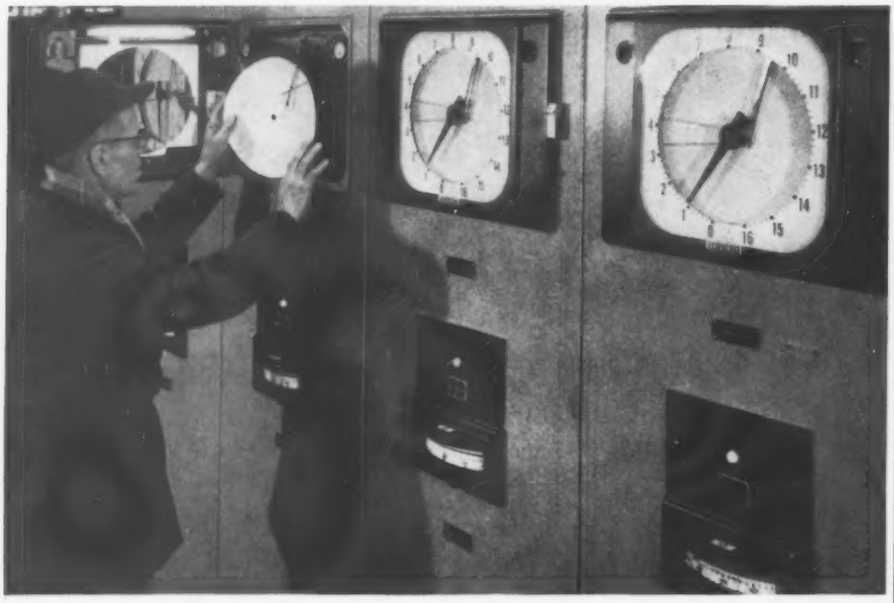
BRISTOL'S

Instrumentation News

• *News of instrumentation and automatic control in industrial heating and metallurgy* •



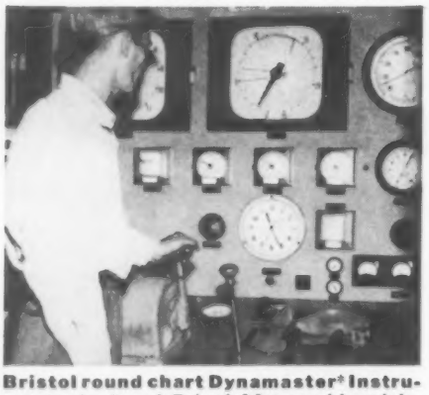
Instruments help turn out casting cores at 7 tons/hour

Engine blocks for Ford and Mercury automobiles are cast with strictest attention to accuracy and structural quality at the Cleveland foundry of the Ford Motor Company, Brookpark, Ohio, just outside Cleveland.

Yet these rigorous requirements must not impede the smooth flow of the production line. That's one reason Ford installed this battery of Bristol Dynamaster* instruments.

Another: In the early days, core baking used to be an all-night process. Cores were of fine quality, but the output was too low for present-day production lines. The new core baking method turns out top quality cores at the rate of 7 tons an hour. Bristol instruments automatically hold the baking temperature to 450° ± 5°F. And, in emergencies, allow faster processing by raising the temperatures and increasing conveyor speed.

First oxygen steel plant uses Bristol controls



Bristol round chart Dynamaster* Instruments (top) and Bristol Metagraphic miniatures (center row) play a big part in controlling oxygen steel-making at Dominion Foundries & Steel, Ltd.

When Dominion Foundries & Steel, Ltd. (Dofasco), at Hamilton, Ontario, first introduced this method of steel-making to the North American Continent, they chose Bristol instruments and controls (above) to supervise the most critical steps in the process.

These include oxygen pressure and flow (current rate and total), lance position, lance cooling water temperature, flow, and pressure as well as various other temperatures.

The big advantage of oxygen steel-making is the lower original investment in equipment. Only about 50% of the equipment costs of competitive processes is required and operating costs are no higher, with equal or better product.

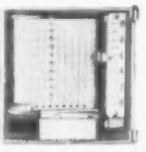
Furnace, oven, dryer— Bristol controls them all

Whatever your industrial heating application, you can find a Bristol instrument or instrument system to provide precision indication, recording or automatic control. The following instruments, in almost innumerable variations, are typical of the truly complete Bristol instrument line.

Bristol's Dynamaster* Potentiometer Pyrometers come in round or strip chart models, provide electronic recording, indication, and electric or pneumatic control, including high-low contact, proportional, time-program and many combinations. The outstanding instrument for maximum precision.

Bristol Millivoltmeter Pyrometers. Both indicating and controlling models available. Controlling models utilize unique Bristol Free-Vane* principle that completely eliminates relay "chatter" or "flutter." High-low contact and proportional models available in a wide variety of combinations.

Bristol Miniature Instruments – Bristol is the only company offering a complete line of instruments in both miniature *and* full-size for all recording, indicating and control applications, both electronic and pneumatic. True plug-in construction. Ideal where panel space must be conserved.



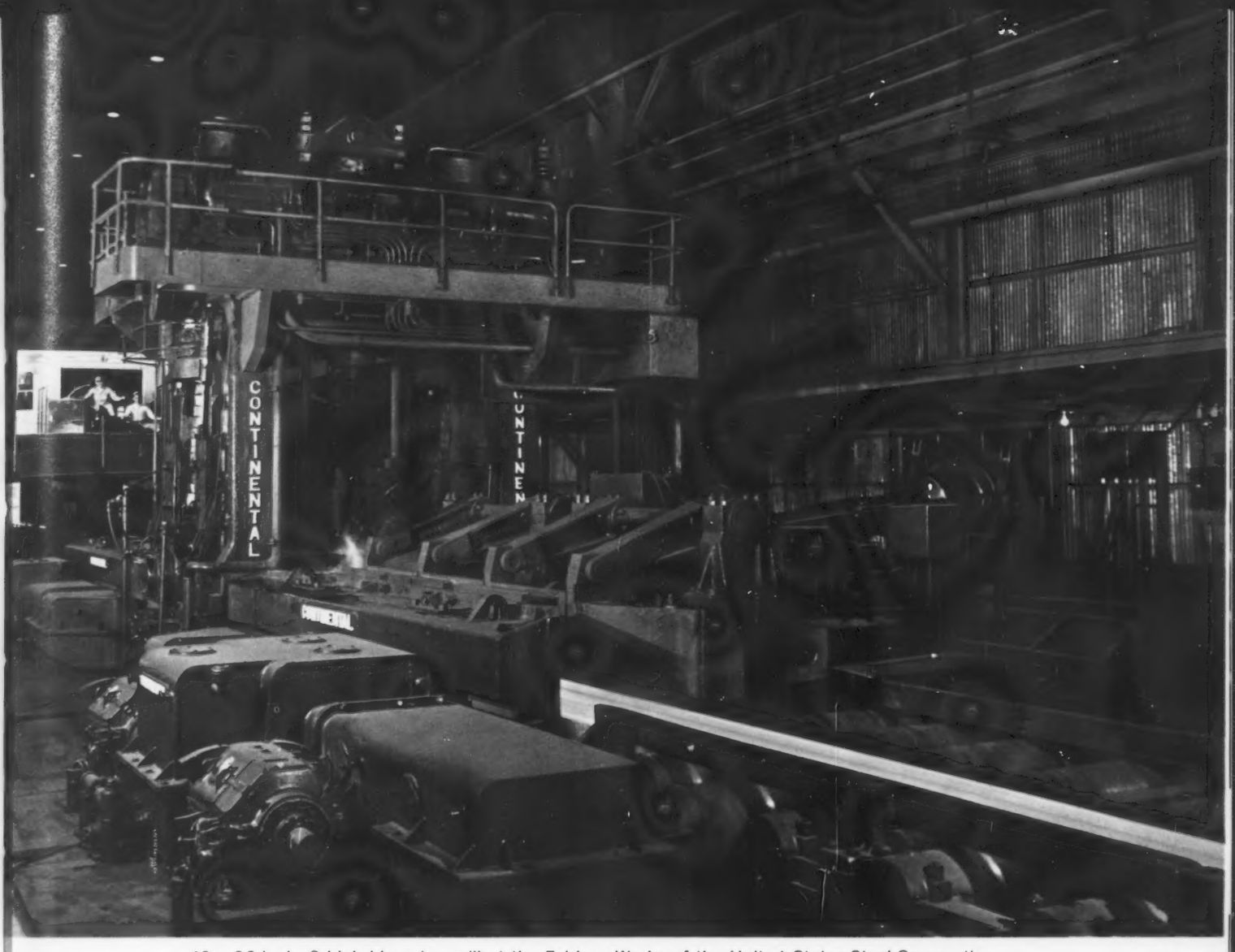
*T. M. REG. U. S. PAT. OFF.

Write for complete data on Bristol instruments for your furnace, oven, dryer or kiln. And remember, Bristol makes a complete line of thermocouples and pyrometric accessories. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

B-26

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



40 x 96 inch, 2 high blooming mill at the Fairless Works of the United States Steel Corporation.

from Steel Making to Steel Finishing

BLAW-KNOX Equipment

Serves the Steel Industry

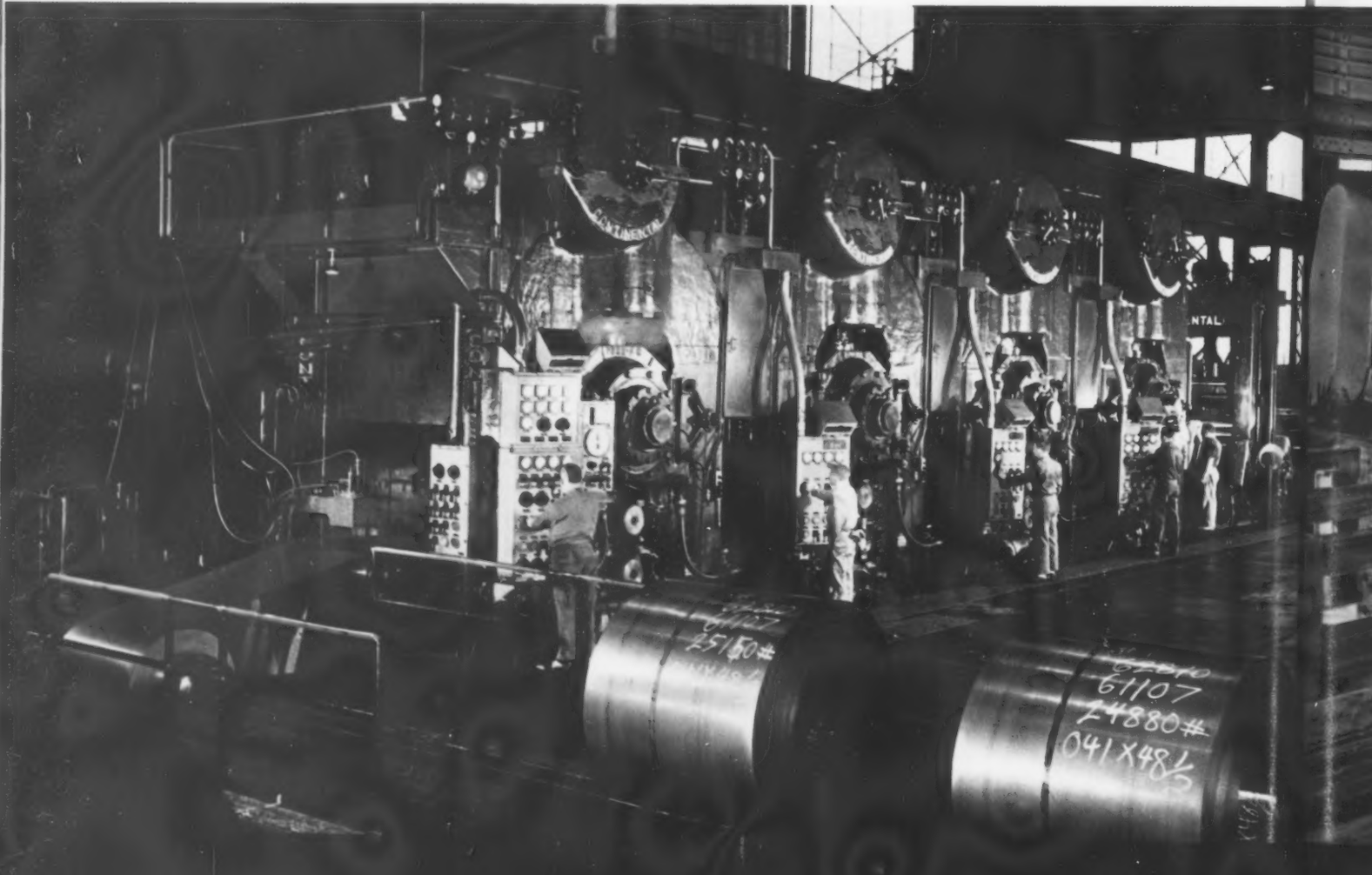
Blaw-Knox custom-designed and built products for the steel industry range from ore buckets to complete rolling mills.

Throughout the steel industry, the Blaw-Knox mark has come to mean exceptional service and the highest standards of performance.

The engineering force and plant capacity behind Blaw-Knox products continues to serve the steel industry in meeting its ever increasing service requirements.

80 inch continuous hot strip mill installed at the Gary Works of the United States Steel Corporation.

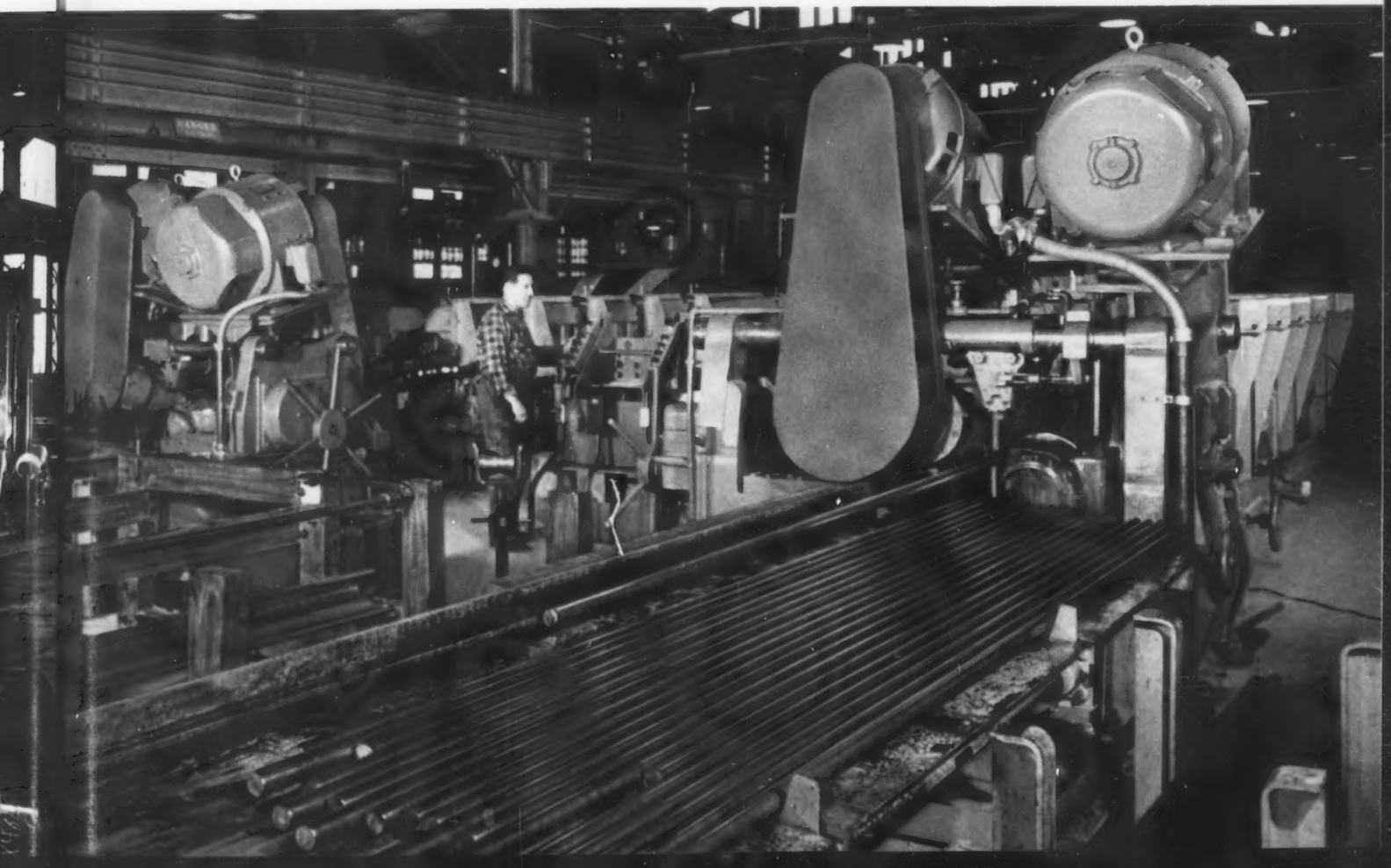
60 inch, 4 stand tandem cold strip mill at the Gibraltar plant of McLouth Steel Corporation.



raltar oughing stand of Merchant Mill installed at Pollak teel Company, Marion, Ohio.

Medart 2 and 2 straighteners on the drawing line of American Steel and Wire's Cleveland Plant.

BLAW-KNOX



Alloy Castings supplied by the National Alloy Division are carrying plate up to 45 feet long, 13 feet wide and two inches thick through a Drever heat treating furnace.

Mechanized open hearth accessories such as the ladle additions feeder provide safer more efficient open hearth operations. In addition, Blaw-Knox supplies water-cooled doors, frames and valves.

This serrated Blast Furnace Bell is part of a wide range of castings made in Blaw-Knox Foundries. Blaw-Knox also supplies iron, alloy iron and steel rolls.

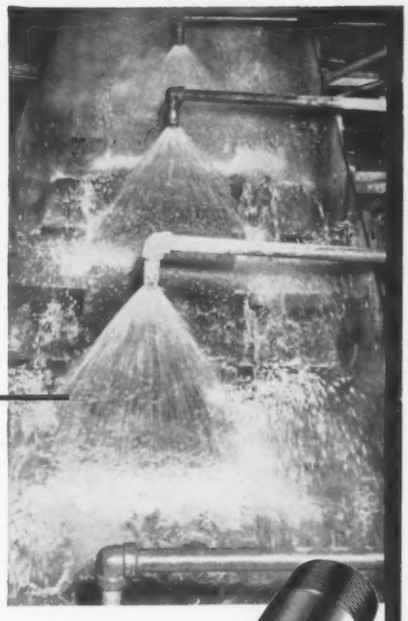
BLAW-KNOX

BLAW-KNOX COMPANY

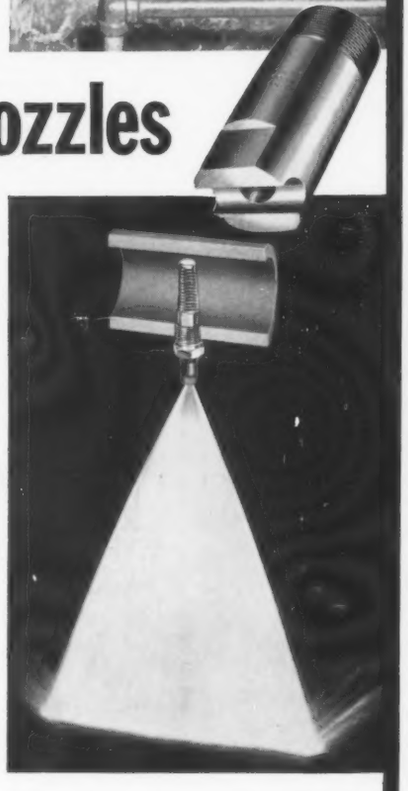
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

every installation a complete success

with Spraying Systems Co.



Spray Nozzles



for hot strip spray cooling descaling roll cooling and related operations

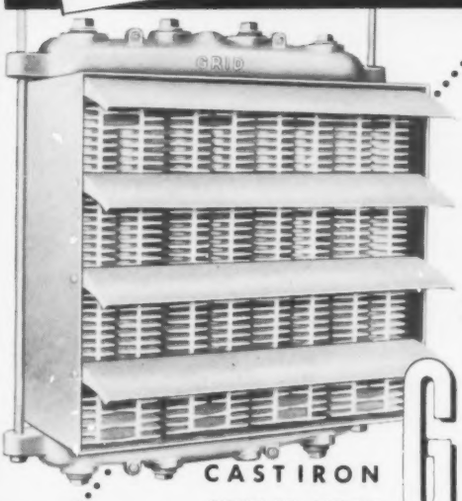
● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.

SPRAYING SYSTEMS CO.

3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.

Corrosion in heating equipment Ends

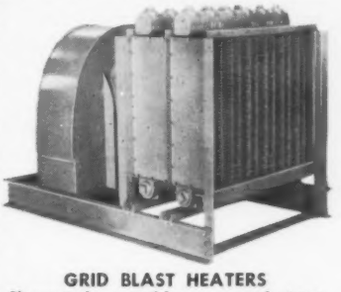


when you install GRID CAST IRON STEAM HEAT TRANSFER SURFACE

UNIT HEATER MAINTENANCE ENDS TOO!

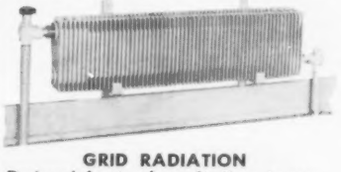
You once and for all eliminate internal electrolytic corrosion because all metals in GRID Cast Iron Steam Heat Transfer Surface that are in contact with steam are similar . . . not 2 or 3 different metals that promote corrosion to cause leaks and breakdowns. GRID Cast Iron Steam Heat Transfer Surface also eliminates external corrosion because its cast iron construction resists acids or fumes in the air. When corrosion in heat transfer equipment ends, maintenance ends . . . it's as simple as that, no mystery, no magic, no "sales" talk. Your heating problems are no longer problems . . . you do away with high maintenance costs, repair work and the nuisance of leaky heating equipment.

GRID Cast Iron construction eliminates the use of reducing valves where high steam pressures are used. It is designed to withstand steam pressures up to 250 P.S.I. . . . 450° temperature. GRID Cast Iron Steam Heat Transfer Surface does away with replacement costs because GRID is built to last for years . . . operating successfully without maintenance in many plants since 1929. Sounds worth looking into? Then get the complete story today . . . come the heating season, you will be glad you did.



GRID BLAST HEATERS

Shown in fan assembly . . . rugged, strong and economical heat transfer surface designed for the tough job . . . for low and high steam pressures . . . requires less labor for installation and less cubical space.



GRID RADIATION

Designed for tough applications in conjunction with high steam pressure systems, GRID Radiators eliminate the use of pressure reducing valves . . . will withstand steam pressures up to 250 P.S.I. . . . adaptable for factory, shop offices, store rooms laboratories, etc.

Send for the complete story on GRID Unit Heaters, GRID Blast Heaters, and GRID Radiation for steel plant use . . . it is contained in GRID Products Catalog No. 956. Write today for your copy.

D. J. MURRAY MANUFACTURING CO.

WAUSAU • WISCONSIN

OUR 75TH YEAR 1883 TO 1958

BIG STEEL NEEDS BIG CRANES

Alliance engineers have incorporated the use of special alloy and USS T-1 steels in the construction of the biggest ladle crane yet—this outstanding 525-tonner to be installed at United States Steel's Fairless Works Division of United States Steel Corporation. Use of these special metals, where practical, results in reduction of wheel loads, and permits installation on existing runways now carrying 450-ton cranes. This keeping ahead of all facets of crane design-engineering has established Alliance as the leader in the big crane field. Why not talk to the Alliance engineers in Alliance or Miami? They'll help solve your material handling problems quickly and economically.

Alliance

THE ALLIANCE MACHINE COMPANY
Main Office: Alliance, Ohio
Branch Office: Miami, Florida

"Give us the Runway and we'll lift the World"

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

Equipment News...

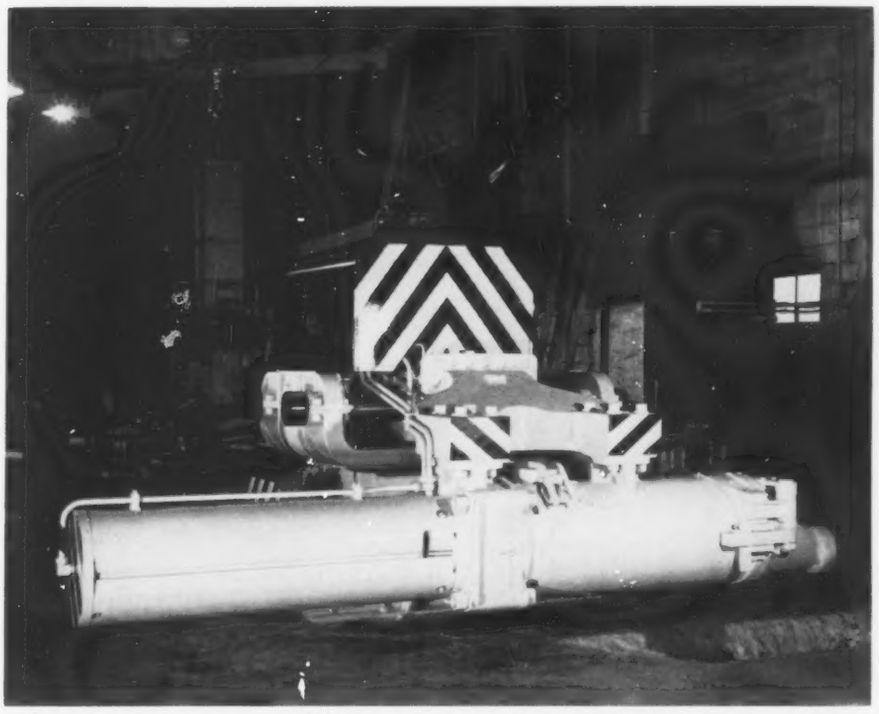
WIRE ROPE

△ A new type of wire rope combining the flexibility and abrasion resistance of Lang lay rope with the stability of regular lay rope under severe operating conditions has been announced by the Wire Rope Division of John A. Roebling's Sons Corp. Herringbone wire rope is a new construction employing two pairs of Lang lay strands and two strands of regular lay. This new wire rope has relatively large outside

wire construction to take the pressure and abrasion of contact with sheaves and drums, combined with smaller inside wire construction so patterned as to provide the maximum flexibility in service.

Performance of Herringbone wire rope over a three year field test period has been superior in such varied service as shovel ropes, wagon scraper ropes, dragline ropes, holding and closing lines and general hoisting. Field tests on excavating equipment have indicated that performance of the Herringbone wire rope was superior even when the equipment was under the control of an unskilled operator.

Test results indicate superior flexibility, good resistance to shock and abrasion, smooth operation around drums and sheaves, easy spooling properties and exceptional structural stability. These properties indicate Herringbone wire rope can serve a dual purpose, eliminating the need for stocking Lang lay rope for one type of service, and regular lay rope for others.



New clay gun features efficient new concepts for stopping the tap holes of blast furnaces. It was designed for the industry's trend of larger, greater capacity and higher top pressure furnaces. The option of 12 or 15-cu ft clay barrels guarantees ample clay without refilling the barrel during plugging.

CLAY GUN

△ Salem-Brosius, Inc., has introduced a machine featuring efficient new concepts for stopping the tap holes of blast furnaces. This new Sabro clay gun incorporates features compatible to the trend throughout the ironmaking industry toward the larger, greater capacity and higher top pressure furnaces.

All motions of the new clay gun are hydraulically actuated and electrically controlled through solenoids operating the hydraulic control valves. There are no gears, tracks, pinions or racks, principal points of maintenance in guns heretofore manufactured; and all relative motions between the clay carrying chamber and the supporting structure or boom have been eliminated. This permits a travel path into the blast furnace tap hole that is positive, accurate and in proper position every time. Adjustments permit change of gun path to meet operating needs.

The standard gun delivers clay at pressures up to 800 psi at the nozzle, assuring proper tap hole closure regardless of furnace size. Higher pressures can be obtained if required. The option of 12 or 15 cu ft clay barrels guarantees ample clay without refilling the barrel during plugging. By a unique mechanical wedge design, the nozzle of the gun is locked into the tap hole without mechanisms or latches mounted on the furnace or furnace columns.

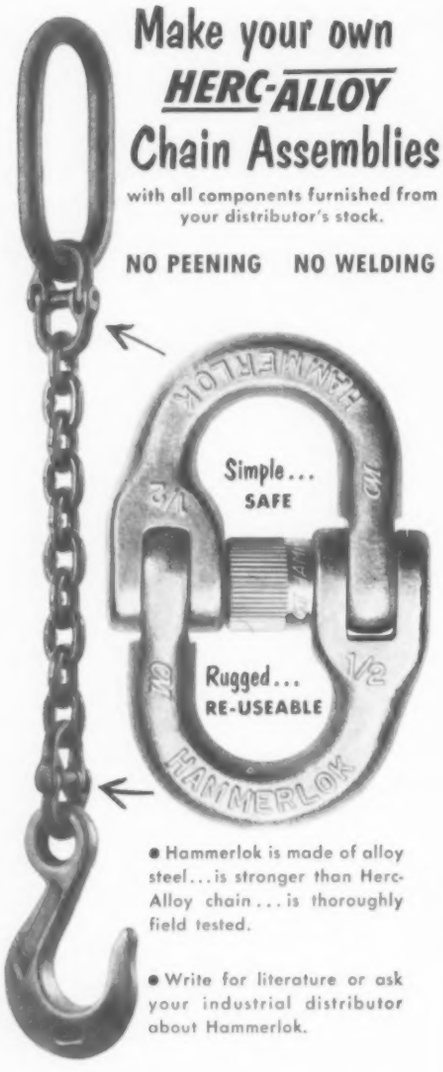
The gun is a pedestal or self-mounting type, so designed that it can be used on either the right or left hand side of the iron notch. Fittings permit mounting the clay barrel, electric motor, hydraulic pump and rotation-tilt hydraulic motor on either side of the pedestal. These are of unit construction, so that wiring, piping and all components are changed as single assemblies.

Push button controls permit either automatic or single stage cycling of the gun, offering peak flexibility of operation. Noninflam-

CM
Hammerlok®
COUPLING LINK

Make your own
HERC-ALLOY
Chain Assemblies
with all components furnished from your distributor's stock.

NO PEENING NO WELDING



● Hammerlok is made of alloy steel... is stronger than Herc-Alloy chain... is thoroughly field tested.

● Write for literature or ask your industrial distributor about Hammerlok.

● MADE BY the makers of Herc-Alloy... the original alloy steel chain.

CM
HOISTS AND CHAIN

COLUMBUS McKINNON
CHAIN CORPORATION
TONAWANDA, NEW YORK
DISTRICT OFFICES: NEW YORK
CHICAGO • CLEVELAND
In Canada: McKinnon Columbus Chain Limited, St. Catharines, Ontario

mable hydraulic fluid throughout the hydraulic system guarantees against any possibility of fire from accidental failure of hydraulic lines or fittings and exposure of hydraulic fluid to fire or hot metal.

The clearance required to swing the gun from its loading to tapping position is a semi-circle with a radius of only 10½ ft. The pivot point or longitudinal centerline through the pedestal is 6 ft from the centerline of the iron notch of the blast furnace.

The motions of the gun in sequence are: Rotation from loading position to a position parallel to and directly over the iron notch, an arc of 180 degrees; tilt to put the nozzle end of the gun down into the iron notch; traverse to carry nozzle into the tap hole in proper position; and extrusion of clay from the barrel of the gun into the tap hole.

The rotation and tilting motions operate on a 900 psi hydraulic system, supplied from its own 10 gal capacity hydraulic fluid reservoir. Traverse and extrusion functions operate on a 2500 psi hydraulic system from a 65 gal capacity hydraulic fluid reservoir.

Electric motors to meet any current characteristics can be supplied. The motor driving the high pressure system pumps is a 30 hp, totally enclosed, induction motor, while that on the low pressure system is a 3 hp totally enclosed motor.

For greater ease of maintenance, the gun has been designed so that there are only five lubrication points.

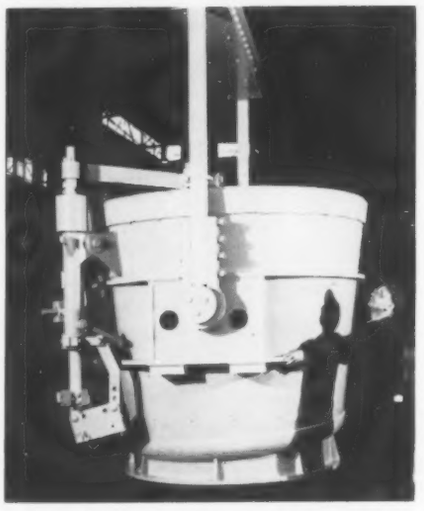
HYDRAULIC PRESS

△ The first hydraulic extrusion press to be built in Germany for the extrusion of steel tubes and sections has been operating for some months in several shifts. The makers, Schloemann AG, Düsseldorf, are at present erecting in Japan a further plant of this type, which in addition to the 1600/1800 ton extrusion press with runout trough, includes a 630-ton piercing press, a cooling bed, a 160-ton stretcher and a pressure water station.

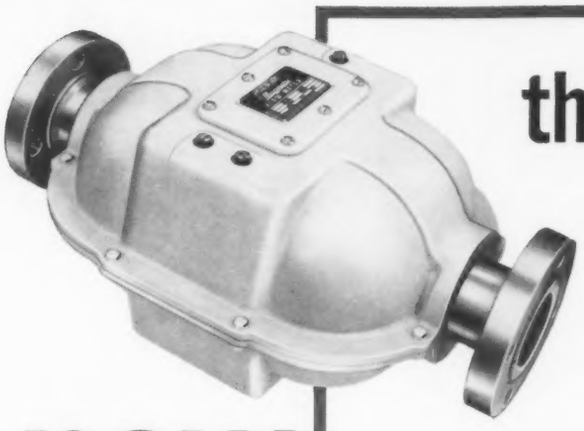
The press will produce tubes as well as solid and hollow sections of plain and alloyed steels. Starting billets have a diameter of 160 to 200 mm at a maximum length of 800 mm and will be extruded at 1100 to 1250C (2012 to 2282F). Operation is according to the SéJournet glass lubricated process in order to prevent scale, to insulate from heat and to reduce friction. The time of contact between material and tools during extrusion must be kept as short as possible so as to obtain sufficient strength and life of the mandrels and dies. Consequently the delivery speed of extrusion is very high. The extruded stock is sent to a stretcher where it is untwisted and straightened. This also results in removal of the vitreous skin which may still be found on the material.

The press can be fully automatically controlled in five programmed sequences or electrically by hand as individual control. The automatic control permits the client to obtain an extrusion sequence of 45 to 60 sec in accordance with the intended production program. This means an output of 60 to 80 extrusions per hour.

PONY LADLE



This 35-ton welded steel ladle will be used in the new process of vacuum pouring steel ingots. Designed and manufactured by Blaw-Knox Co., the ladle will receive molten metal from a 200 or 250-ton open hearth ladle and transfer it into the vacuum chamber, where the ingot molds are filled. Primary purposes of the intermediate, so-called "pony" ladle, is to maintain the vacuum during the pouring. The ladle is equipped with a Blaw-Knox Autopour mechanism which will operate the ladle stopper by remote control.



the meter with NO flow restrictions

now handling all these difficult liquids

Foxboro's first Magnetic Flow Meter went "on stream" in 1954. Today, this new-type meter has gained industry-wide application for precise, continuous measurement of difficult process liquids.

The Magnetic Flow Meter is installed as simply as a length of pipe. No seals, purges, meter runs, or straightening vanes are required. It connects by standard electric cable to remote Dynalog Electronic Recorder. Over-all accuracy of the system is ±1%. And the meter even measures reversing flows.

With easy-to-measure liquids, or with tough ones like those listed below, the performance-proved Foxboro Magnetic Flow Meter provides flow measurement with no line restrictions. For complete details, write today for Bulletin 20-14B. **The Foxboro Company, 589 Neponset Ave., Foxboro, Mass.**

METALS AND MINING

pickling acid
sand slurry
ferrous chloride
limestone shale slurry
bauxite slurry
gilsonite slurry
aluminate liquor
uranium ore slurry
thickener mud
cement slurry
flue dust slurry
acid wastes

CHEMICALS

ammonium nitrate solution
phosphate slurry
rayon viscose
magnesium carbonate slurry
phosphoric acid slurry
detergent concentrate
rosin size
starch solution
rubber copolymer
liquid latex
soda ash
sulphuric acid
70% sodium hydroxide
soap flow
styrol
magnesium hydrate

FOOD

beer
grape juice
apple juice
pineapple juice
tomato juice
milk
starch slurry
sugar syrup
coffee slurry
molasses

PULP & PAPER

all types of pulp stock sizes
spent liquors
cooking liquors
alum
lime mud slurries
dyes
bleaching chemicals

OIL INDUSTRIES

drilling mud
phosphoric acid
ethenol extract
scrubber recycle water
urea solution
nitrate solution
spent acid
sodium silicate & water
sodium chloride brine
tar-sand slurry

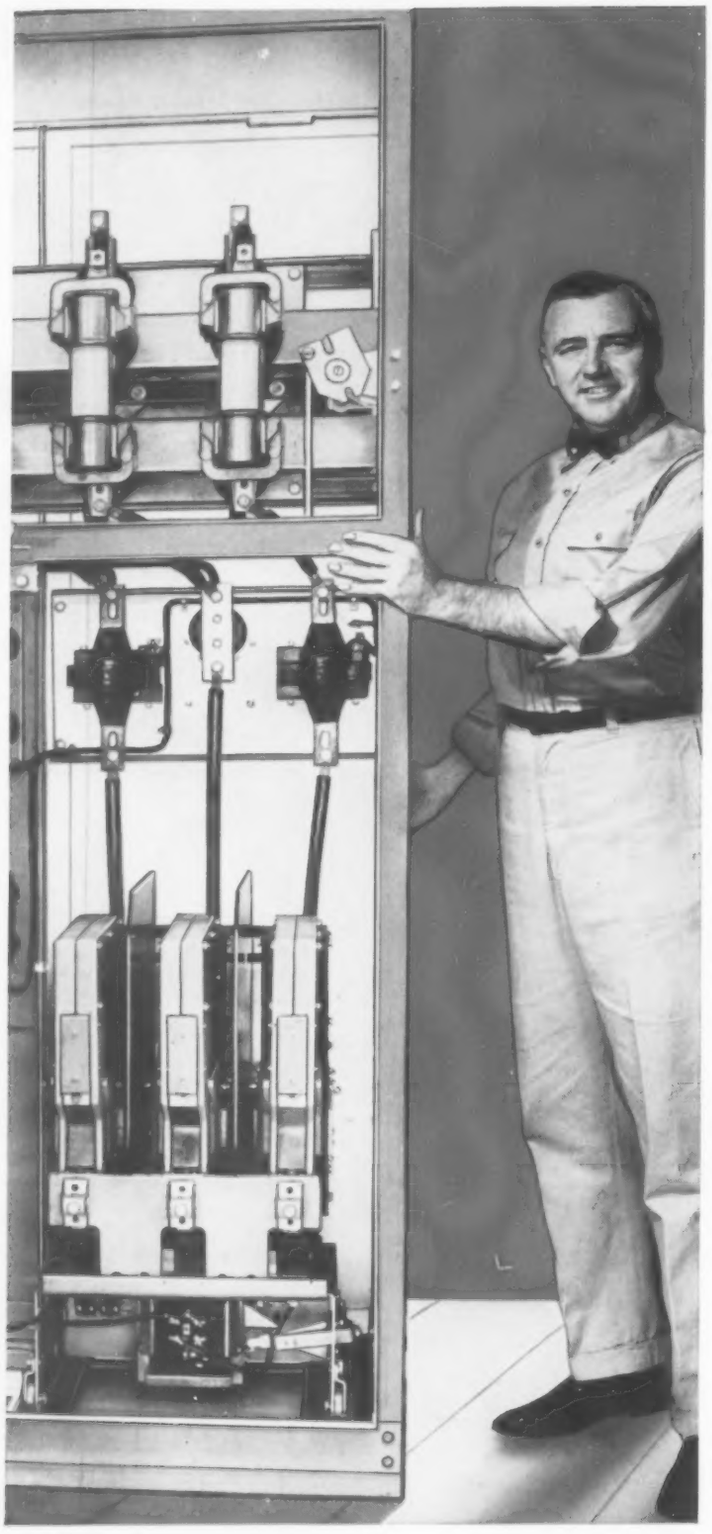
WATER & WASTES

activated sludge
fresh water
raw sewage
digested sludge
primary sludge
return activated sludge

METER SIZES RANGE FROM 3/16 INCH TO OVER 6 FEET PIPE DIAMETER

FOXBORO
REG. U.S. PAT. OFF.

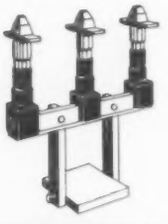
MAGNETIC FLOW METERS



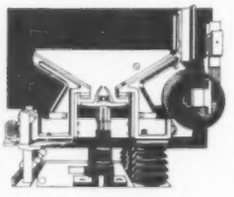
Tough high-voltage job?...Here's the answer!

Allen-Bradley High-Voltage Air Break Starters are ideal for frequent switching, reversing, plugging, or jogging.

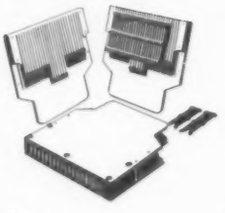
A tremendous operating life has been built into these high-voltage air break starters . . . resulting from the use of the simple solenoid contactor. It's the same design—having only ONE moving part—that provides millions of trouble free operations in Allen-Bradley's low-voltage controls. These starters are made in a complete line for all types of service. Send for Publication 6080, today.



ONLY ONE MOVING PART
With this simple solenoid design, all trouble causing pivots, pins, and flexible jumpers are eliminated. Straight up-and-down motion of contactor is virtually frictionless.



DOUBLE BREAK CONTACTS
Allen-Bradley silver alloy contacts never need maintenance . . . they remain in perfect operating condition until completely worn away. Vertical motion assures uniform contact pressures at all times.



FASTER ARC SUPPRESSION
The air break contactor employs a completely different blowout design and novel arc chute which assure rapid arc extinction. Chutes are molded from arc resistant material.

A-B QUALITY

ALLEN-BRADLEY

QUALITY

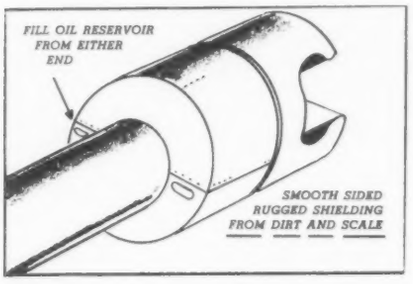
MOTOR CONTROL

Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

SPINDLE LUBRICATOR

△ A new unitized spindle lubricator designed to bring the many advantages of centralized lubrication to one of the costliest maintenance problems found in a reversing, blooming and slabbing mill—spindle slippers—has been developed by Trabon Engineering Corp.

Here are some reported results from a typical mill: Slipper life was doubled. Tonnage rolled per slipper set on the mill end jumped from about 125,000 tons to 250,000 tons. Lubricant consumption



dropped. (One barrel to a few quarts per shift.) Decrease in shock loads (savings in power consumption) transmitted to bearings has resulted in a 400 per cent or better increase in bearing life.

The unitized spindle lubricator is a self-contained fully automatic system which delivers a measured amount of lubricant into the pressure areas of the slipper. Heart of the new mechanism is the feeder valve.

One of the exclusive features of the new unitized spindle lubricator is its rugged "grip" mount for holding the lubricator on to the spindle.

The new unitized spindle lubricator can be adapted to any reversing, slabbing or blooming mill spindle.

GUNNING MIX

△ A new basic refractory gunning mix for use in steel furnaces has been developed by the Kaiser Chemicals Div., Kaiser Aluminum & Chemical Corp.

The mix, marketed under the name of K/R 95, is a highly refractory Chrome-Periclase mix designed for use with the K/R Gunning System for either hot or cold maintenance of back and front walls of open hearths and the sidewalls of electric arc furnaces.

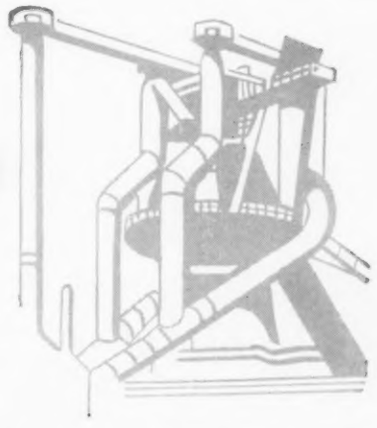
K/R 95 is applied above the slag line and in uptakes and has excellent adherence to vertical walls. It can be used as a companion product with K/R 165, a high magnesia Periclase mix used for open hearth bottoms and tap hole maintenance.

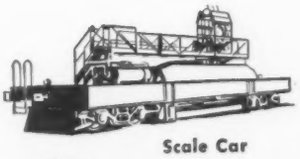
Because of its neutral characteristics, the mix is highly resistant to iron oxides and can be used safely on top of basic brick or adjacent to acid bricks, particularly in skewback areas.

For hot repairs, K/R 95 is designed to balance furnace life where trouble spots develop. Applied in cold maintenance work the product hardens into a dense, homogeneous mass and is particularly adapted for resurfacing areas over old brick.

The K/R Gunning System has been in use for about two years by the steel industry. The RTH-5 gun is designed for continuous trouble-free operation rather than requiring batch mixing. The mix is fed continuously into the system through two hoppers which supply the unit's main reservoir. Water is added at the nozzle and the material is shot at 40 psi through a 1½ in. diam lance. Lances of varying lengths are interchangeable depending upon the area to be reached.

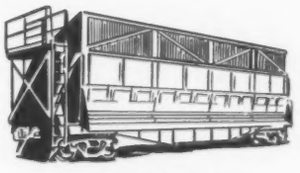
WHEREVER *performance* COUNTS





Scale Car

100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

Each car is engineered to meet the operating needs of the plant where it will be used.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

Consult Atlas for your Steel Plant Cars

ENGINEERS AND MANUFACTURERS SINCE 1896

Material is gunned at a rate of 240 lb per minute without pulsation or interruption.

The gun itself is relatively light in weight and portable. Pivots make it possible to fold the main body of the equipment to a maximum height of 23 in. to permit clearance of the charging machine.

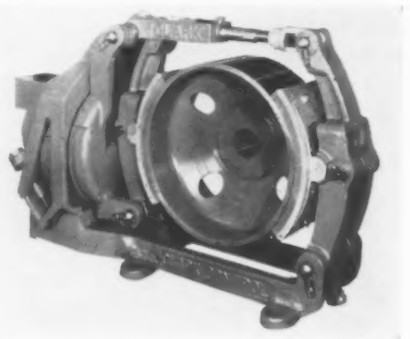
D-C BRAKES

△ A new line of d-c motor brakes, featuring high rigidity, simplicity of adjustment and easy servicing without disturbing torque adjustment, has been introduced by the Clark Controller Co. The line includes 10, 13, 16, 19 and 23-in. wheel sizes.

The Bulletin 106 d-c brake line meets NEMA-AISE standards, for use with NEMA 600 series mill-type motors and equivalent sizes of standard motors.

The brake utilizes a "nut-cracker" design, hinged at the top, for equal distribution of applied pressure. A unique mounting method holds shoes in spring-loaded sockets without depending on pins to connect them to the arms. A partial turn of a wrench releases pressure so that shoes can be slid out to the side without removing the wheel. Brake shoes are self-aligning and are interchangeable end-for-end and with each other.

All maintenance adjustments can be made from the top of the brake. A single adjustment, with built-in indicator, sets the air gap. The magnet case and coil can be removed and replaced without releasing the brake. Removal and replacement of the brake wheel and motor armature, as a unit, can be accomplished without disturbing torque adjustment. All adjustment, maintenance, assembly and disassembly can be accomplished with a screwdriver and adjustable wrench.



Shoe wear adjustment is accomplished simply by loosening one locknut turning an adjusting screw and relocking.

The main torque adjustment spring is at the bottom of the brake, totally shielded and protected. Internal screw adjustment keeps the adjusting stud from protruding beyond initial position.

The brake coil is encapsulated in baked epoxy plastic. The magnet armature is hinged at the top with widest part of the air gap at the bottom to allow dirt to fall free and not be trapped.

Of cast steel construction, with cast aluminum shoes, the brake has pressure lubricated Nitralloy bushings and hardened pins. All parts are designed for rigidity and accurate fit.

Optional features include a safety flanged wheel, and manual brake release with either automatic or manual reset.

VERTICAL MOTOR

△ The Louis Allis Co. has introduced a new weather protected vertical motor intended for outdoor operation under all weather conditions including hurricane winds, driving rain, snow, sleet and wind-blown

The BLOOM Time-Cycle Reversal Unit assures FULL, FAST AND EFFICIENT REVERSAL OF REGENERATIVE FURNACES AUTOMATICALLY

This complete, compact, factory-tested unit provides a combination electric-pneumatic system for Open Hearth Furnace and Soaking Pit reversal. It elimmates reversal puffing and shortens reversal period. (10 to 15 seconds easily accomplished).

Shorter reversal cycle improves furnace life.

These units have been in continuous service for nine years. Trouble-free maintenance.

BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

WRITE or phone for complete information on the Bloom Time-Cycle Reversal Unit.

FELLER ENGINEERING CO.

presents

SCHLOEMANN

Cold rolling mill for narrow and medium strip

When particular characteristics are specified as, for example, 'edges as rolled,' cold rolling mills for narrow and medium strip are needed. They are also the most economical solution in the case of a rolling program varying widely in grade and quantity.

Tandem mill and single mills

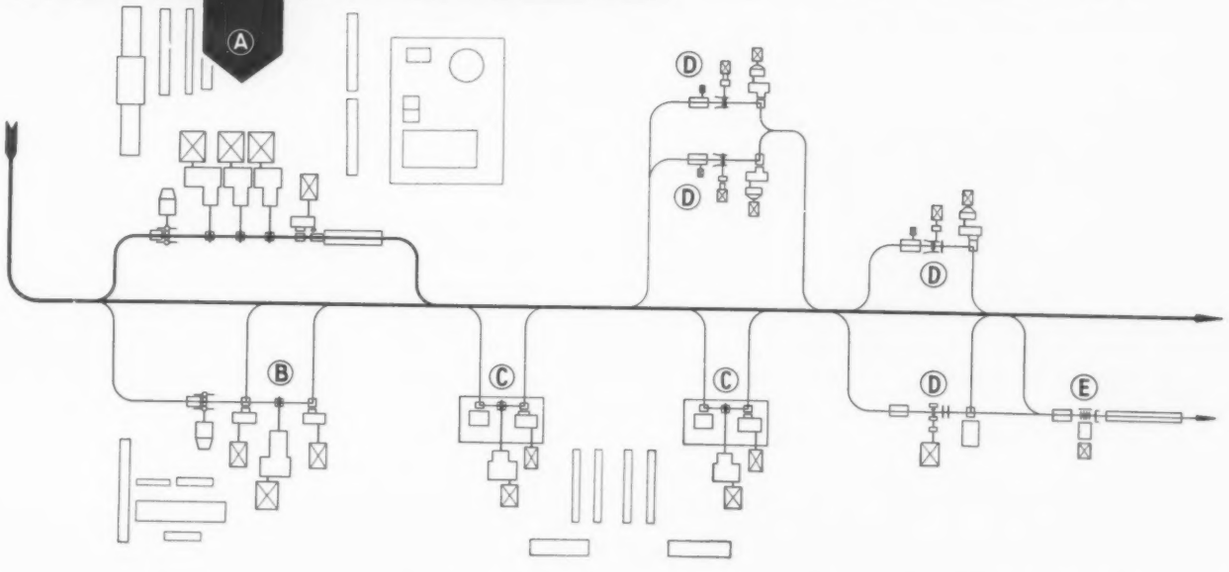
The main part of the plant is a tandem mill (see photograph) consisting of three four-high stands having a roll diameter of 20½/8¼, 20½/7, and 20½/7 inches with a body length of 16 inches. As three passes are generally required to obtain the final thickness, most hot-rolled strip passes the tandem train which permits reductions of up to 80 per cent in one passage. Should further passes be necessary, a four-high reversing cold rolling mill is used having the same roll dimensions. This mill can also serve to roll small-batch orders.

Two multi-purpose cold rolling mills with rolls 10/2¼ diameter by 16 and 10/2¼ diameter by 12½, which can operate two-high or four-high, permit a further extension of the range of the rolling program without the use of a large number of mill units.

Rolling program and production

The entire plant with electric drives and auxiliaries was planned, built and put into operation by SCHLOEMANN. Strip up to 13 inches wide with a carbon content up to 1.25 per cent is rolled from 14 BG up to $\frac{3}{16}$ of an inch down to a minimum of 0.004 inch thickness. By arranging a three-stand tandem mill with high draft, and by the use of multi-purpose rolling mills, only six roll stands produce from 1,000 to 3300 tons per month, and a wide-range rolling program can be carried out with low requirements in space and personnel.

A. Tandem mill
B. Four-high reversing mill
C. Multi-purpose mill
D. Slitting shear
E. Combined leveller and flying shear



FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

Assuring the dependability of B-L-H nonferrous castings . . . the probing eye of the spectrograph

The position and intensity of the lines shown by the microphotometer indicate the metallic content of the alloy under analysis in relation to the standard.

Spectrographic equipment includes (far left) the spectrograph; the excitation stand (door open), and the new 1000 v source unit purchased specifically for analysis of the copper base alloys.

A truly vital factor in careful quality control of nonferrous castings at B-L-H's Eddystone Division is spectrographic analysis, a quick and accurate 2-step method. First the characteristic lines of colored light of each metal in the alloy being analyzed are registered on film in a highly controlled manner. Then, by interpreting the position and intensity of these lines, the composition of the alloy is determined.

B-L-H uses the spectrograph to check both incoming metal and outgoing castings. Each lot of virgin metal and each lot of prepared alloy ingots are analyzed to make certain they measure up to Baldwin's specifications. The casting, too, as it comes from the mold, is subjected to spectrographic probing, an evaluation of its quality being returned to the foundry the same day it is poured.

Whenever required, chemical analysis is also available. Baldwin's chemical and spectrographic laboratories are closely coordinated. Frequently both tackle the same problem as a safeguard against error.

Job shop or high production foundry work, forming alloy castings of multiple composition and weighing from a few ounces to some 50 tons each—whatever the requirements, our extraordinary shop facilities have the means to take them in stride. The quality control exercised by our superbly equipped chemical and physics laboratories assures you of satisfaction. Write today for our illustrated Foundry Bulletin 6002.

Excitation stand immediately following burning of a sample of an alloy. Glowing white light indicates hot electrodes.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

sand. The motor meets NEMA Type II weather protected specifications and is manufactured in ratings from 250 to 2000 hp, in both hollow shaft and solid shaft construction.

The motor is cooled by ventilating air taken from the surrounding atmosphere. To free this air of harmful moisture and dirt before it enters the heart of the motor, it goes through three 90 F changes in

direction, is lifted vertically through screens and expands in an air passage so that velocity is reduced to less than 600 fpm.

The motor's bearing construction, as standard, provides high thrust capacity. A maximum of two-high angular contact bearings are used to eliminate multiple bearing misalinement. Kingsbury Type Thrust Bearings are available for extra high thrust applications exceeding the capacity of angular contact or spherical roller bearings.

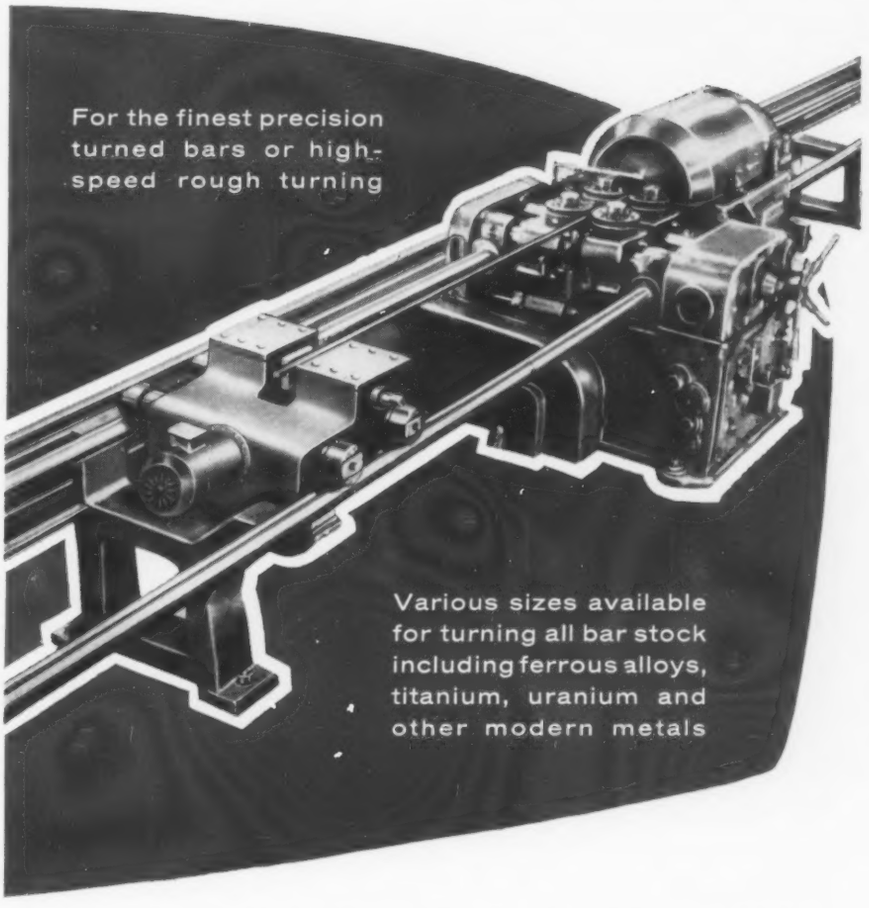
OIL-GAS BURNER

△ E. W. Bliss Co. announces the availability of the radiant pulsation-type oil-gas burner. Already widely tested in a variety of industrial heating applications, the burner produces a powerful luminous flame with a peak temperature of 3450 F when burning oil, and above 3300 F with 1000 Btu/cu ft natural gas. Burners are available for heat release rates ranging up to 70,000,000 Btu's per hour.

The unusually efficient com-

(*Please turn to page 298*)

SUTTON CENTERLESS BAR TURNING MACHINES


For the finest precision turned bars or high-speed rough turning
Various sizes available for turning all bar stock including ferrous alloys, titanium, uranium and other modern metals

Now—for precision turned bars, you can get a surface finish of better than 10 micro inches! Ovality tolerances of plus or minus .00025″ and diameter variations better than plus or minus .001″ are achieved in any 20′ length of bar stock from ½″ to 9″ Dia. Machines can be arranged for fully or semi-automatic operation with bar loading and unloading tables for straight-line production.

Sutton Centerless Bar Turning Machines are manufactured in the U.S.A. under license by Sir James Farmer Norton & Co., Ltd.

Ask for complete data

Visit Sutton at booths 474 & 475 AISE exposition

SUTTON *Engineering Company*

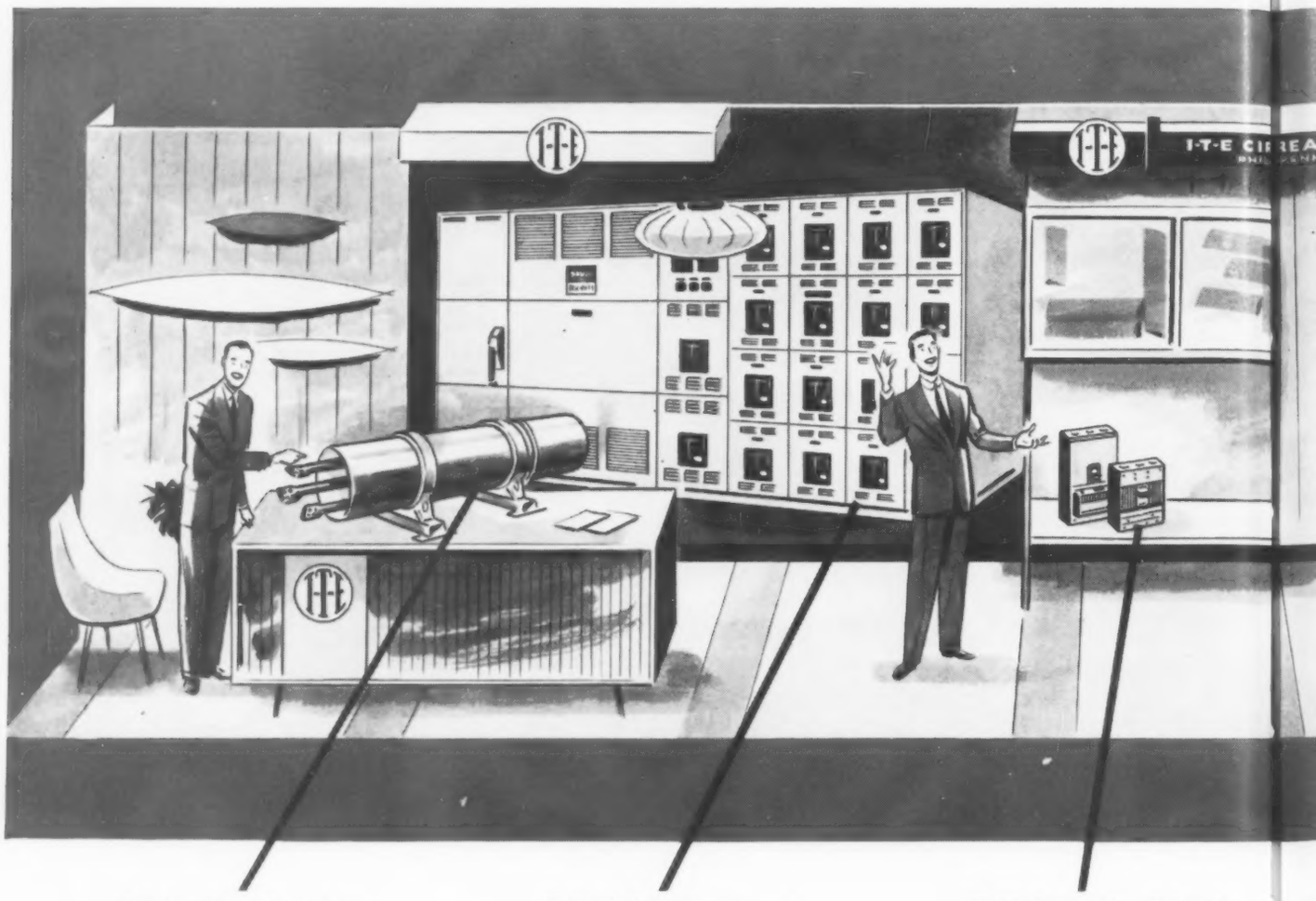
FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.

PHONE: GRANT 1-8077 • PLANT: BELLEFONTE, PA.

Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Processing Machines for Modern Metals.

Now See the Real Thing... See I-T-E

Booth 841 – AISE Convention, Public



Metal-enclosed bus. Non-segregated phase bus completely sealed in air, and porcelain insulated. Cork neoprene gasketed split-half round covers provide completely sealed bus that can be used indoors or outdoors; bare copper or aluminum conductors mounted on purified porcelain with high dielectric strength. Ratings as follows: 4.16, 7.2 and 13.8 kv, 1200-3000 amp.

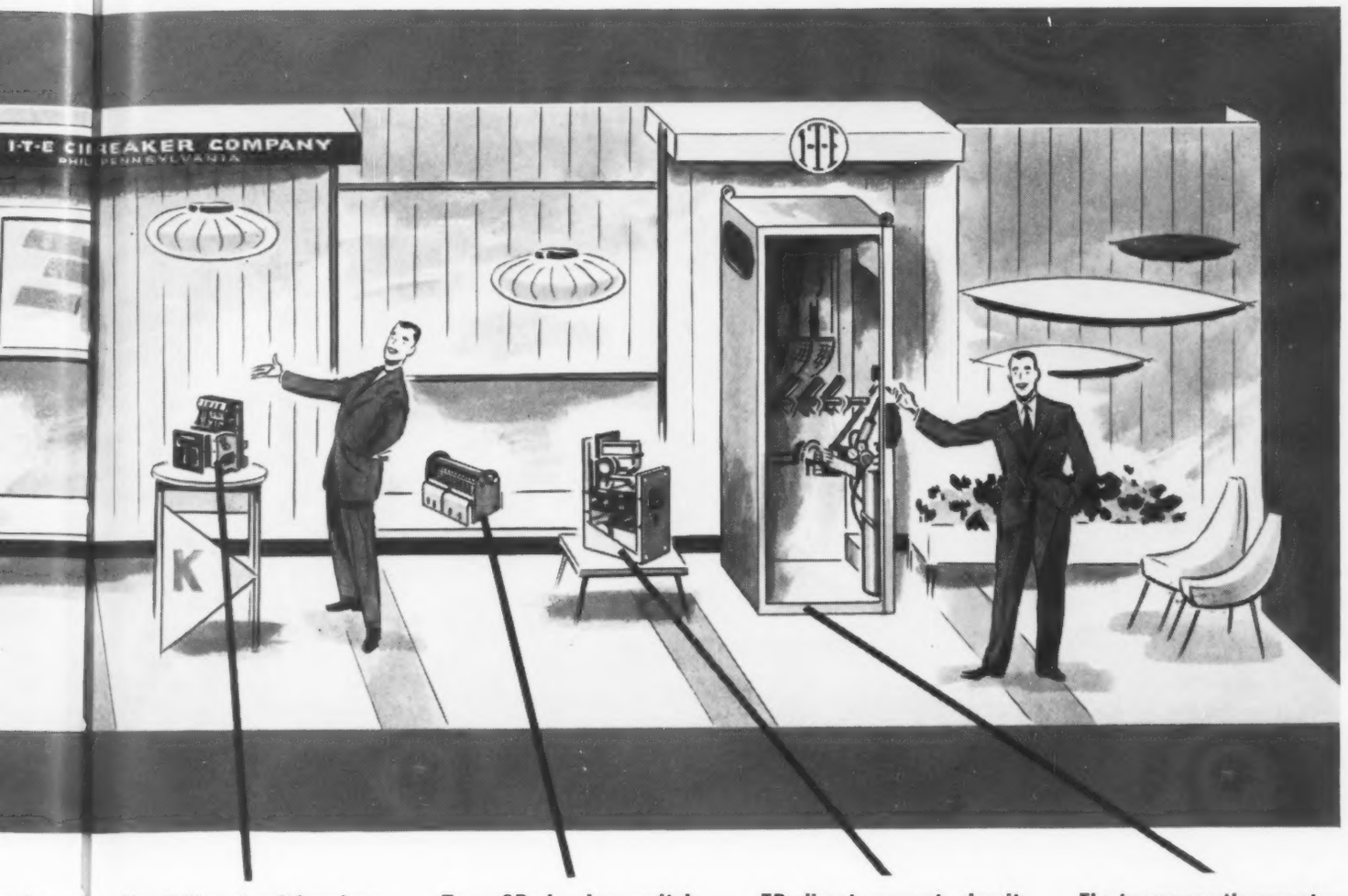
Unit substations. The only unit substations designed and built under one roof. Transformer engineers and switchgear engineers work within walking and talking distance of each other. So you are assured of more perfectly co-ordinated finished equipment. Units shipped from one location, as one package, ready to install. Delivery scheduled to mesh with your construction progress.

Molded case circuit breakers. New JK and JKL models save 40% mounting space in ratings up to 400 amp continuous, 40,000 interrupting at 240 v. Famous I-T-E Cordon® circuit breakers combine inverse time element action with current limiting amp traps to give up to 100,000 amp interrupting capacity in a molded case device. Other sizes and models will also be displayed.

During your free time visit our Hospitality Suite
Room 345, Statler Hotel

Electrical Equipment On Display . . .

Auditorium, Cleveland, Ohio, Sept. 23-26



New K-Line circuit breakers and low voltage metal enclosed switchgear. Exciting new design. Quick manual make means new safety, less upkeep, longer contact life. Breaker can be completely disconnected with the door closed. Has the additional advantages of new expanded calibration overcurrent trip device, equipping every breaker to handle higher loads when they come.

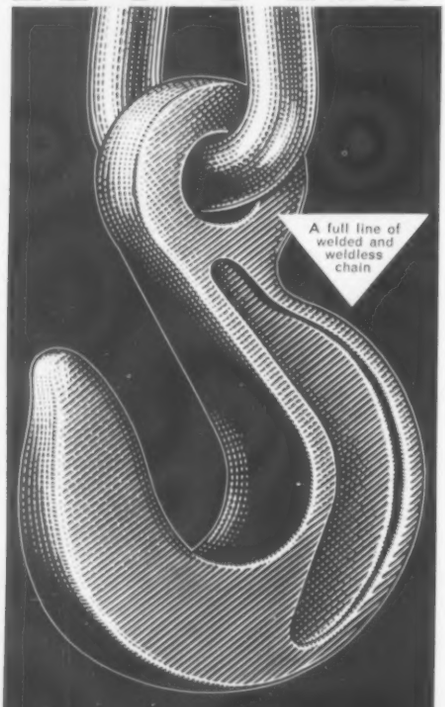
Type CR d-c bus switch. Tremendous switching capacity in small space. For electroplating and furnace buses, short circuiting electrolytic cells, and other similar applications. Handles up to 12,000 amp and 250 v. As many as 16 switches can be connected and operated from a single operating handle. Arranged to form the number of poles you need—single or double throw.

FB direct current circuit breaker. Small in size. Complete current limiting protection against fault currents of 1000 to 125,000 amp. Fast action mechanism opens breaker in only 12 milliseconds. Keeps fault currents low. Available in single or multipole models. Up to 5000 amp continuous current and 1000 v d-c. Available with either stationary or drawout mounting.

Electropneumatic operator for power switches. Push a local or remote button and you can open or close your type HPL-C power switches pneumatically . . . fast, surely and in complete safety. With suitable relays and circuitry, switches can operate automatically. New electropneumatic operator gives you this extra convenience at far less cost than motor or hydraulic devices.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

PATENTED
TAYCO HOOKS



another advantage of
TM factory-made
alloy sling chains!
Pat. No. 2646306

Patented Tayco Hooks are the strongest on the market, for they are drop-forged from special alloy steel with exclusive I-Beam design! Uniform heat-treating, stress-free links, Taylor's quality control and Test Certificate on assembled sling are additional advantages of TM factory-made Alloy Slings. Call your distributor or send for Bulletin 13.

S. G. TAYLOR CHAIN CO., INC.
Hammond, Indiana
3505 Smallman St., Pittsburgh, Pa.

Taylor Made CHAIN SINCE 1873

(*Continued from page 295*)

bustion achieved by the pulsating flame is enhanced by catalytic action of a special refractory liner to realize fuel savings over conventional burners that range from 12 per cent as high as 30 per cent. Moreover, the flue gas is exceptionally clean, with no carbon monoxide. In one drying application, this characteristic made it possible to substitute a direct fired Bliss radiant burner for a completely enclosed burner of conventional design operating through a heat exchange cycle, with resultant improvement in drying efficiency and fuel economy.

The radiant aspirator pulsating burner uses 3-psi compressed air to atomize fuel metered into the air stream.

Use of conventional industrial oil and gas burners has been limited by their inability to achieve flame temperatures above 2900 F for gas and 3100 F for oil. Thus, oil and gas have never been competitive with pulverized coal, for example, which produces a flame temperature in the neighborhood of 3300 F. The Bliss radiant burner, on the other hand, can readily match this temperature level with 1000 Btu natural gas, and surpass it utilizing oil as a fuel. In recent tests at a foundry company producing cast iron mill rolls, an air furnace used to melt closely-controlled roll alloys was successfully fired with two of the new burners operating on natural gas. Even though costs of the coal previously used were unusually low, the economies effected by eliminating coal handling costs and reduced furnace maintenance will result in a net saving of approximately 40 per cent of total furnace operating costs when applied to all five of the foundry's air furnaces.

The ability of the radiant burner to duplicate or better the flame temperatures and heat release rates of pulverized coal burning furnaces makes it attractive to steel plants and foundries where air furnaces are used either for melting or for holding molten metal at pouring temperatures.

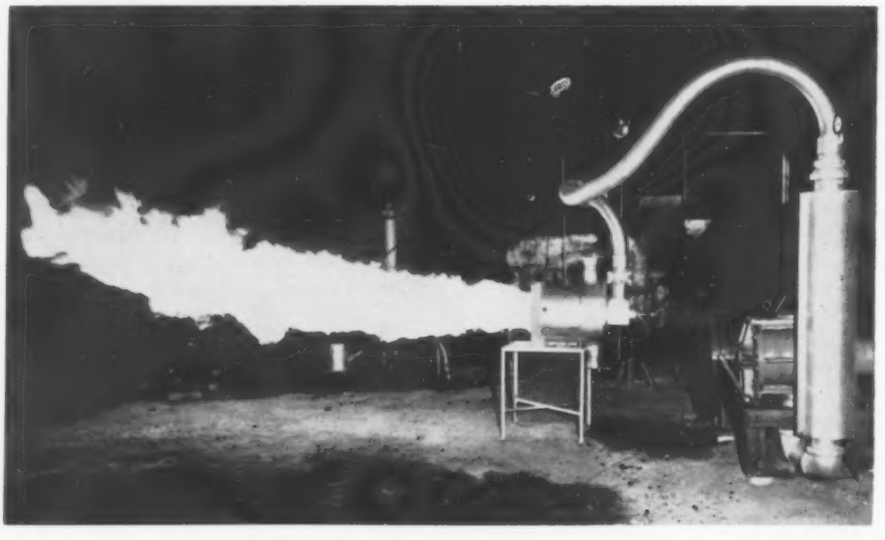
There is literally no limit to the industrial and commercial applicability of these new burners. Because of their high efficiency, cleanliness of combustion and economical fuel consumption, they are directly competitive with many types of industrial heating processes which until now have been unchallenged by either gas or oil. By the same token, no other existing design of industrial oil or gas burner can approach their flame temperature, rates of heat release and efficiency of combustion.

CRANE CONTROL PANELS

△ The world's largest soaking pit crane—a 75-ton giant with a 10½-ft tong opening—built by Alliance Machine Co. for Lukens Steel Co., incorporates many new design-features including space-saving front-connected d-c crane control panels manufactured by General Electric Co.

A total of five panels, one for each of the crane drives, is used. Since

Radiant pulsation-type burner on test stand. The burner shown here is operating at about half capacity.



Youngstown Sheet and Tube normalizing furnace lined with B&W Insulating Firebrick

Designed and constructed by Salem Brosius, Inc. for the Campbell Works of Youngstown Sheet and Tube Company, Youngstown, Ohio, the 57′ x 38′ inside chamber of this huge new walking beam furnace is completely lined with lightweight B&W Insulating Firebrick.

This giant furnace is used to normalize seamless oil well casings and operates continuously at a temperature of 1700 F.

The B&W IFB used in the walls and suspended roof of this furnace are the lightest insulating firebrick made. This light weight and consequent low heat storage keep furnace walls at uniform temperature to provide the most efficient heating conditions. B&W IFB also reach uniform temperature faster with less fuel consumption, which means appreciable savings to furnace operators.

In addition, lightweight B&W IFB make possible more economical suspended roof constructions. They also simplify brick installation and replacement.

For information on how B&W Insulating Firebrick can lower your furnace operating costs, consult your B&W Refractories Representative or write for Bulletin R-2-H.

B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R-500

no rear access is required for wiring or maintenance, the panels provided the solution to an acute bridge space problem which precluded the use of previously-available crane control panels.

Use of the newly-designed panels has also made possible a reduction of 24 in. in the required bridge approach distance—a significant saving for Lukens which makes possible increased utilization of the soaking pit. To prevent the trolley from hitting the extreme travel bumpers at full speed, a special trolley slowdown zone has been provided at both extremes of the bridge ends. Special control circuitry for the trolley drive automatically applies an armature shunt in conjunction with the proper series resistance for slowdown. Design engineers pointed out, however, that the crane operator can safely plug the drive in the slowdown zone without slipping the driving wheel.

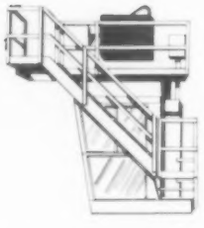
Tong-opening range of the crane is from $2\frac{1}{2}$ to $10\frac{1}{2}$ ft. This unusual flexibility is made possible by the use of interchangeable tong heads. An 8 to 1 rope reduction in the hoist has simplified gearing and reduced sizes and loading of ropes. Upper sheaves of the crane are protected by the use of springs to absorb inertia of the hoisting column in the event of failure of the normal power limit spot.

Power for the tong hoist is supplied by a 265-hp, mill-type motor in conjunction with a front-connected, reversing, dynamic braking, lowering control panel.

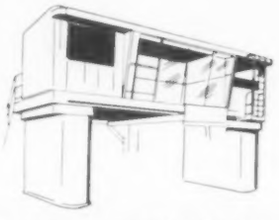
The crane—first to be equipped with the new General Electric control panels—will be used in connection with new steel plate facilities at Lukens.

NEW CAB UNIT by Lintern

Ceiling Mounted Cab Unit



for Cabs and Pulpits



Mounts on Ceiling, Floor, or Wall

Smaller, more compact, lighter in weight — for mounting on ceiling, floor, or wall — this new Cab Unit sets a new record in crane cab and pulpit conditioning.

It contains many new features insuring economies in operation, more efficient service.

Now for the first time, for better temperature control, the Pilot Control is mounted *within the Cab Unit* — or may be mounted remotely.

See it at the Iron & Steel Show — booths 107 and 108. Ask for new Bulletin AC-587 describing the many features and advantages of this outstanding product.

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO

GAGE UNIT

△ Pressure, draft, differential and level are directly measured, indicated and transmitted by the new Bailey Meter Co. Multi-Pointer gage unit. This two-indicator unit is also furnished as a pneumatic receiver.

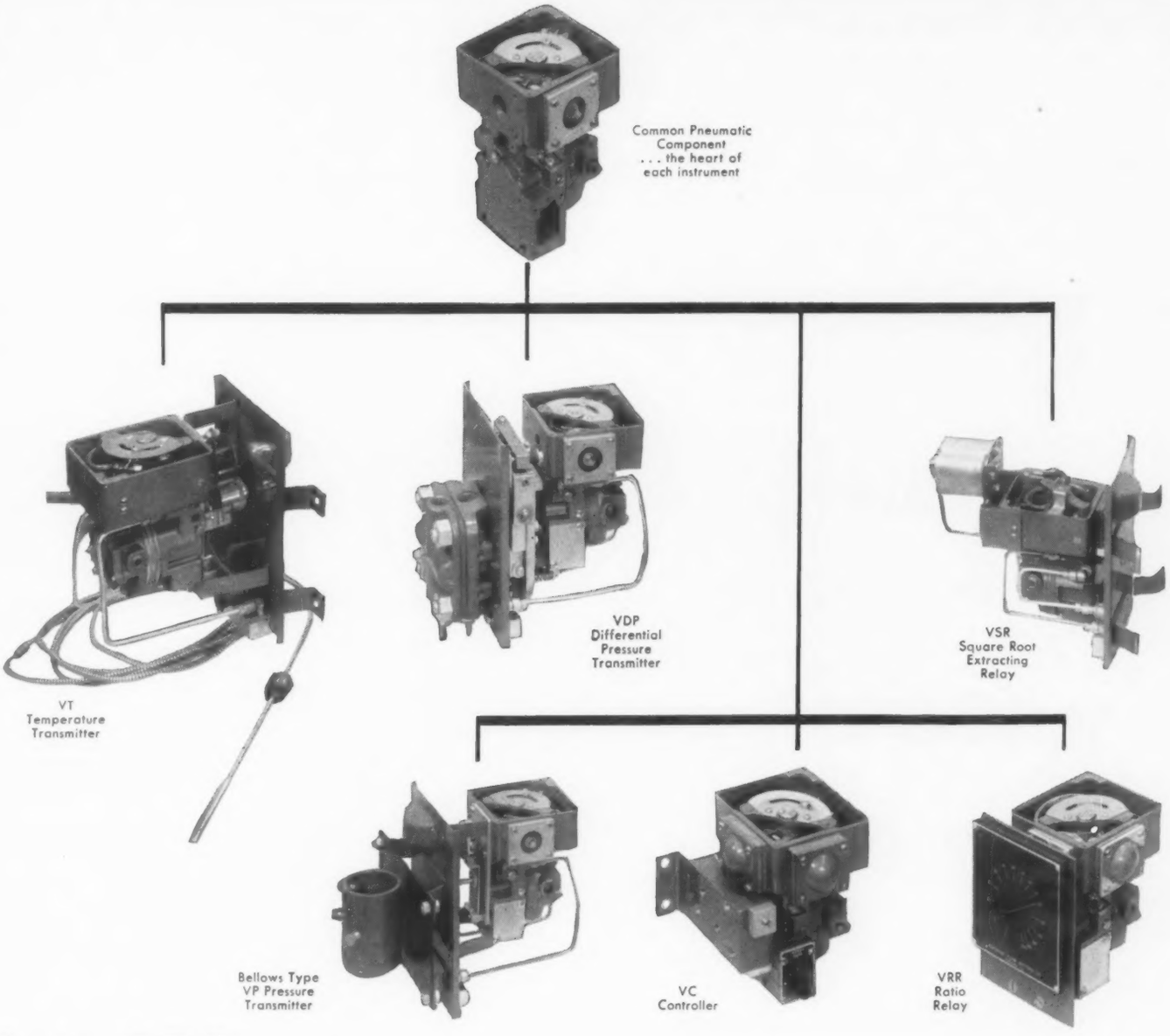
As a direct connected gage, each indicator section may contain a diaphragm element for draft, low pressure or differential measurement; a bellows element for intermediate pressure or level measurement; or a bourdon tube for high

pressure measurement. Standard ranges from 0 to 0.5 in. H_2O to 0–5000 psig are available.

As an indicating receiver each gage unit may contain two pneumatic receiving bellows. The gage unit then indicates any two variables capable of being transmitted pneumatically over standard SAMA signal ranges of 3–15 or 3–27 psig.

As an indicating transmitter, one section of the unit is occupied by the measuring element while the second section contains a pneumatic or an electric transmitter.

Any number of gage units may be


Common Pneumatic Component . . . the heart of each instrument
VT Temperature Transmitter
VDP Differential Pressure Transmitter
VSR Square Root Extracting Relay
Bellows Type VP Pressure Transmitter
VC Controller
VRR Ratio Relay

Rockwell-Built

Republic Vector Series Instruments

serve any process, cut costs too!

You can save substantial money when your control systems are based on Republic's Null-Balance Vector instruments. Each has as its "heart" an identical pneumatic component, with obvious advantages. Among these are interchange of parts, even among instruments performing entirely different functions. Besides involving a minimum spare parts inventory, this feature greatly simplifies personnel training.

Components shown demonstrate the depth of the Republic line. Differential pressure transmitters with 20-to-1 range adjustment . . . temperature transmitters with 10-to-1 range adjustment... pressure transmitters of ±.5% accuracy. We have ratio, totalizing, multiplying, squaring and square root extracting relays. Our all-purpose controllers feature proportional band adjustment of 2% to 500% and reset adjustment from 0.1 to 50 repeats per minute.

The Republic Engineer in your area will be glad to work with you on any control or measurement problem. Sales offices in principal cities throughout the United States and Canada. Call or write—with no obligation, of course.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS

In Canada: Republic Flow Meters Canada, Ltd.—Toronto

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

mounted adjacent on the same panel to provide multiple indications. Seven-in. indicating scales are available in red, green, blue, yellow and orange, as well as white for emphasizing desired variables.

PULLING ELBOW

△ Designed and engineered particularly for use with 90 degree connections using liquid-tight conduit in limited space, Appleton Electric Co.'s new, rugged JIC 90 degree pulling elbow is liquid-tight, weatherproof and dust-tight. A large cover opening provides easy access for pulling wires in any installation while a solid Neoprene gasket gives the best possible seal against damaging elements, liquids, fumes, shavings and other foreign matter.

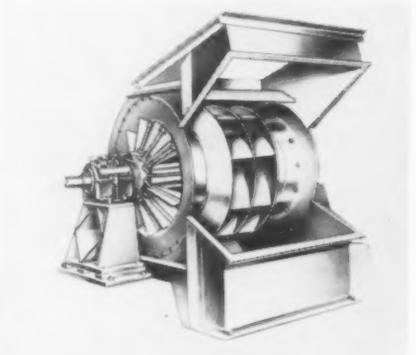
The fitting is made of malleable iron, has a cadmium plate finish and is fitted with a galvanized steel cover for a lifetime of trouble-free service. It is U.L. and J.I.C. Approved.

The wiring chamber of the elbow has chamfered edges throughout to eliminate the burrs and sharp edges that so frequently damage wire. It is available in ½, ¾ and 1 in. sizes. All sizes have a male threaded end to fit standard conduit hubs of any type junction box.

HEAVY-DUTY FANS

△ New Airfoil fans designed specifically for mechanical draft and other heavy-duty applications are now available from Westinghouse Electric Corp. The new units may be used as forced-draft fans for combustion air supply with open inlets; with inlet boxes to handle preheated air, industrial process supply and exhaust applications; and as induced draft fans for oil or gas firing applications.

The fans (Series 4000) are avail-



able in 15 sizes, with volumetric capacities from 10,000 to 700,000 cfm and pressures up to 45 in. of water. They can operate over a temperature range from minus 20 F to 850 F, and have a mechanical efficiency of over 90 per cent.

Since the new fans incorporate Airfoil blading, separation of air flow from blade surfaces is prevented and areas of turbulence are eliminated, thus providing quieter performance for a given duty. The pressure characteristics of the fans also insure minimum reduction in specified capacity when pressures exceed estimated values.

AIR BRAKES

△ Two new air-braking systems, designed to provide smooth power stops and dependable control for heavy industrial equipment, have been developed by Wagner Electric Corp.

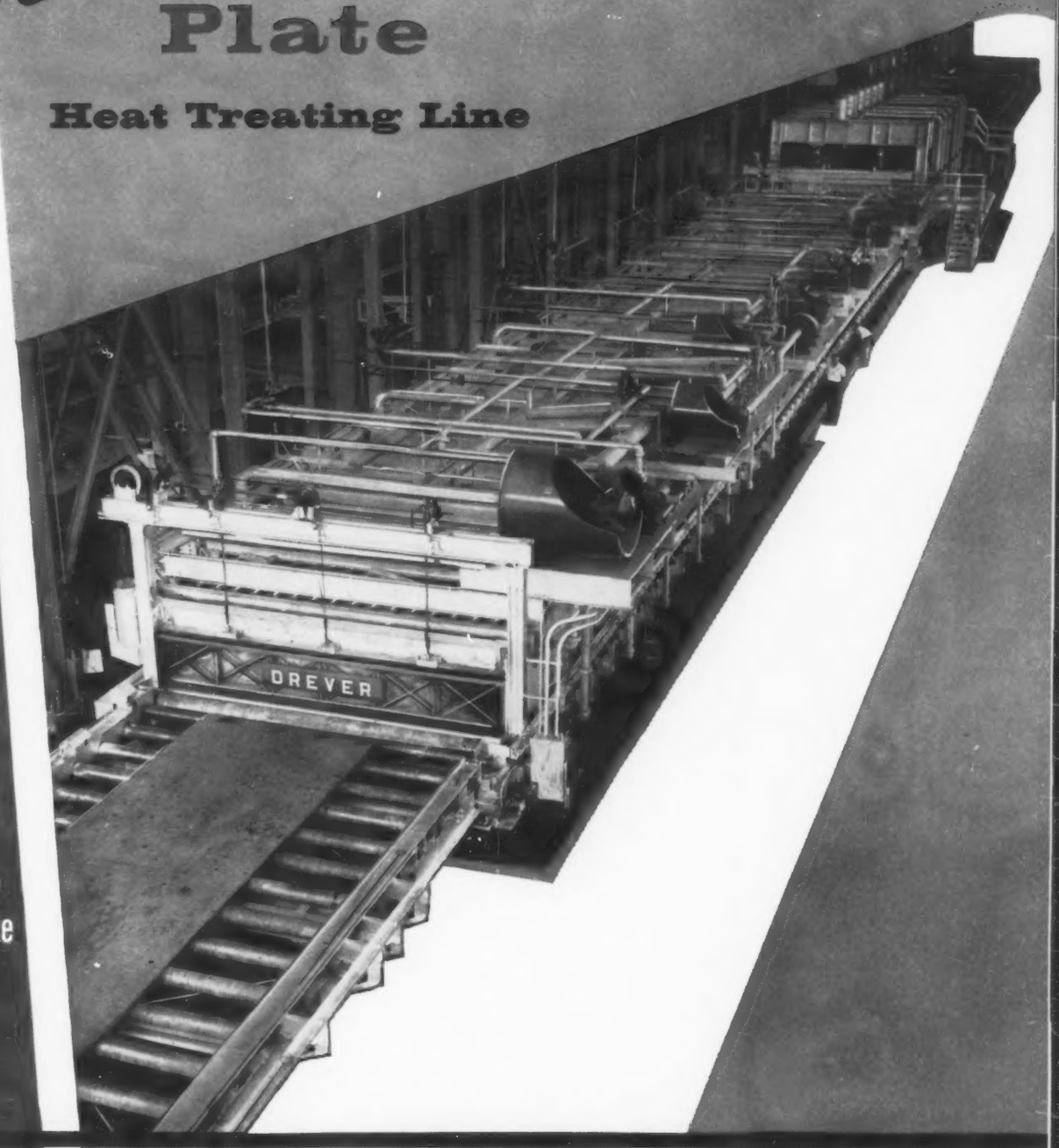
Both systems are available with

(*Please turn to page 307*)

SUPERIOR
CARBON
BRICK
FOR
◀ Blast furnace linings
◀ Blast furnace run-out troughs
◀ Cupola linings
◀ Steel pickling tanks
Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.
May we give you a quotation?
ELECTRODE GLC® DIVISION
GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

DREVER Plate

Heat Treating Line



Shown is the charging end of a 145′-0″ hardening furnace. In the background can be seen a 2500 ton pressure quench, 200′-0″ draw furnace and the operator's control pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172″ wide x 3″ thick x 600″ long.

The furnace rolls are 25/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

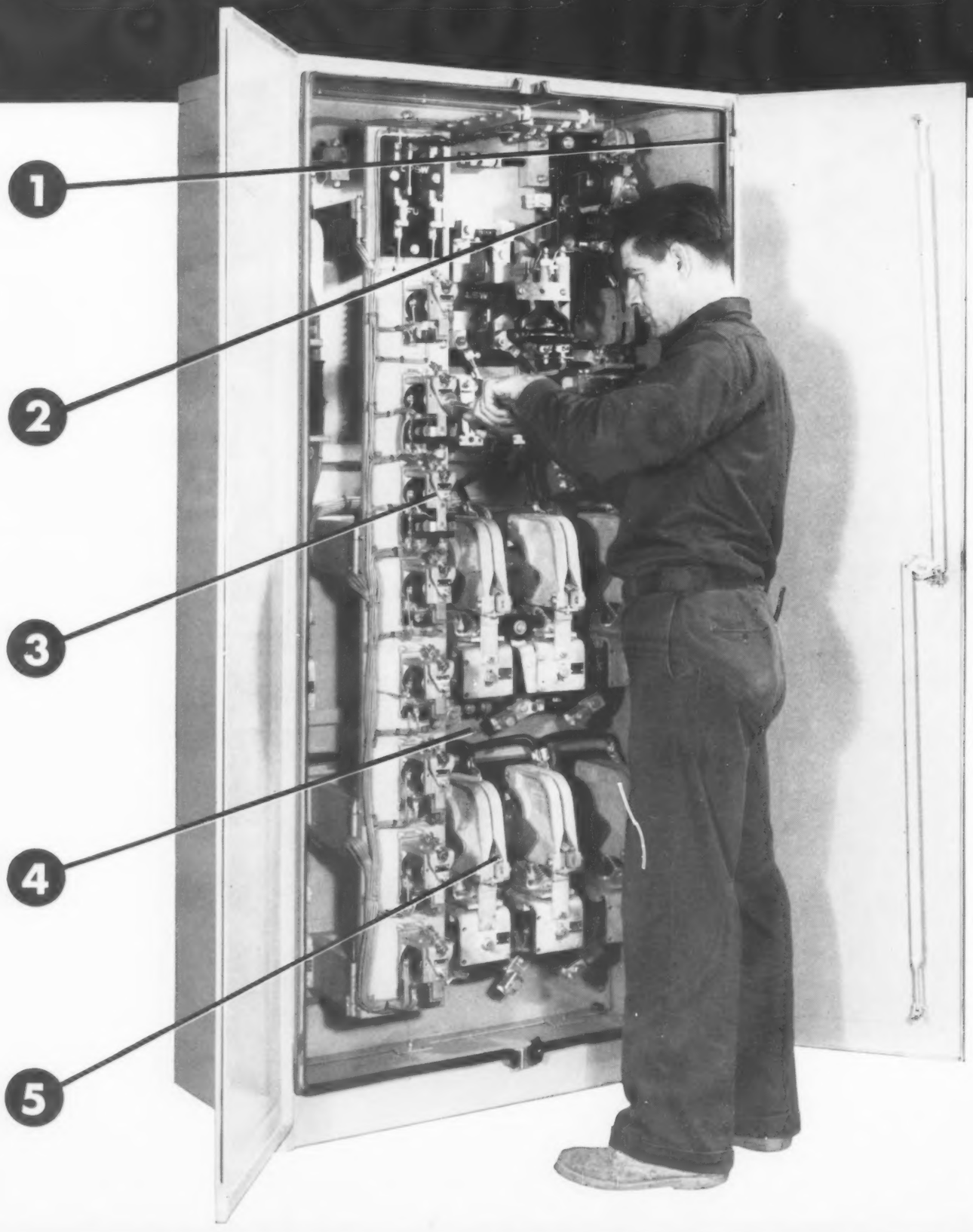
The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.

NEW



all front-connected d-c crane control from General Electric

SMALL SIZE AND ELIMINATION OF BACK AISLE CUT FLOOR SPACE REQUIREMENTS IN HALF!

General Electric announces the only completely front-connected d-c crane control panel on the market today! This new design feature eliminates any need for a back aisle. And here are five *more* reasons why General Electric is your best buy in d-c crane controls:

1. **Doors are quickly removed,** if desired, to provide ample room for installation and maintenance. The doors are hung on hinge pins to simplify removal. The lower pin is shorter than the top pin for ease of replacement.
2. **Devices are better protected** against shock and vibration by mounting on shock-resistant unit-bases. This construction also permits removal of devices as individual units from the front.
3. **Adjustable devices are readily accessible** because they are mounted on a hinged panel near the front of the enclosure. This panel swings open to provide access to a vertical wiring channel for the inter-connecting cables.
4. **Connections are made easy** by convenient terminals. Built-in wire troughs are formed by unit bases of individual devices.
5. **Spare parts are minimized** by use of rugged steel-mill devices, all of which use the same universal interlock for contacts on relays, and for auxiliary contacts on contactors.

Take advantage of this new space-saving design now. *Specify General Electric d-c crane controls!* Ask your General Electric sales engineer for information on the outstanding performance characteristics of General Electric d-c crane control. Or write for GEA-6434, to Section 785-3, General Electric Company, Schenectady, New York. Industry Control Department, Roanoke, Virginia.

UP TO 50 PERCENT LESS FLOOR SPACE is required by eliminating the back aisle and the use of a smaller panel enclosure.

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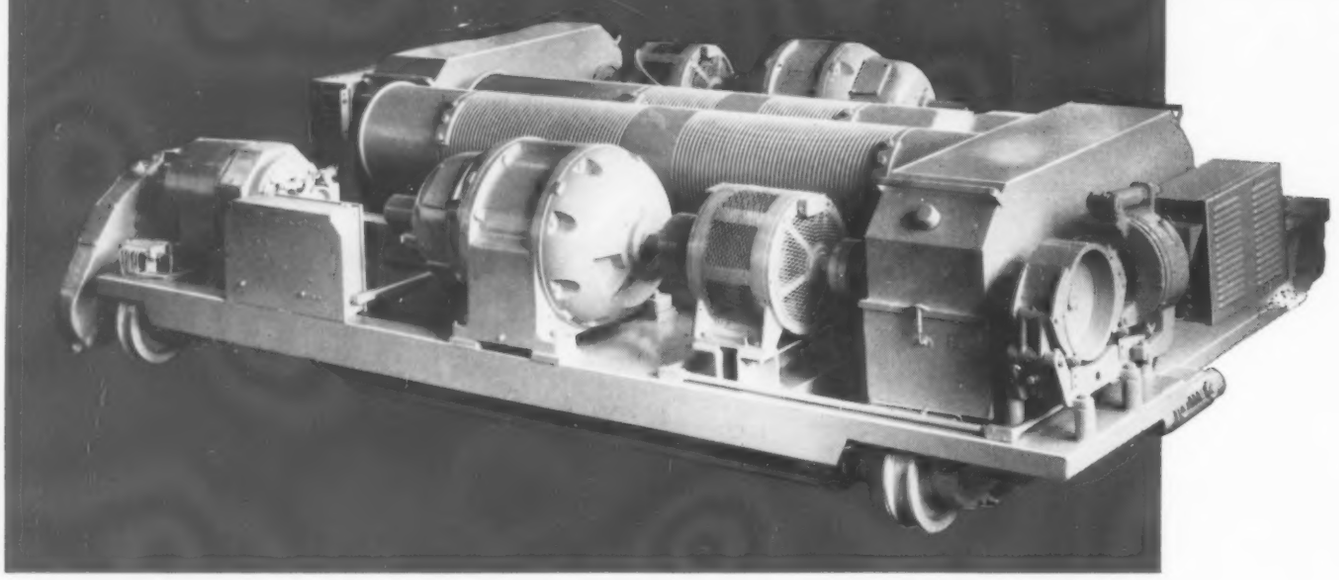
For Northern Cranes

EZOMATIC
CRANE CONTROL



EZOMATIC *is Smooth, Simple, Dependable*

EASIER *to operate*

EASIER *to maintain*

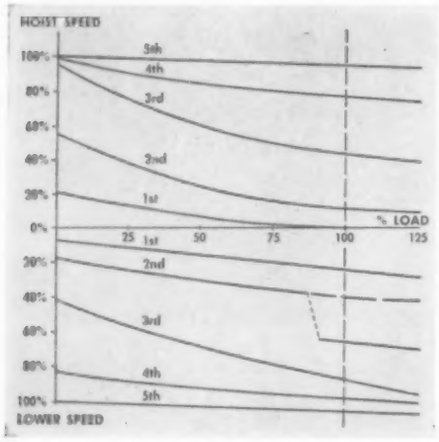
EASIER *to understand*

EASIER *to handle any load*

The new simplified, smooth, accurate control for alternating current hoist motors utilizing full magnetic control combined with an eddy current brake. This improved control arrangement is easier to operate, easier to maintain, makes handling any load easier, safer, more accurate. Regardless of load the speed characteristics both hoisting and lowering are excellent, allowing smooth handling and accurate spotting of any load.

Standard control components familiar to all electrical maintenance and operating men are used throughout. Circuits are simple and readily understandable. No complicated electrical schemes. Used with a standard eddy current brake eliminating mechanical and electrical wear.

Excitation of the eddy current brake is automatically controlled by the motor speed allowing extra smooth acceleration. If fast acceleration is desired it may be obtained by moving the master switch to the last point, thereby eliminating the eddy current brake excitation. Off point braking is provided automatically to assist the motor brake in stopping the load. The motor brake is automatically applied in lowering if the eddy current brake excitation should be interrupted. Speed curves can be readily changed in the field, either up or down by a simple adjustment. When very heavy loads are handled extra lowering speeds are automatically provided.



TYPICAL SPEED CURVES WITH EZOMATIC CONTROL

For further information write to

NORTHERN ENGINEERING WORKS

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(*Continued from page 302*)

the 14 x 6-in. or 18 x 8-in. Wagner external shoe type brake. One system is for making service stops only. The brake is applied by an air actuating cylinder which incorporates a return spring for quick release. The second system is for both service stops and for parking and holding operations; in addition to the air actuating cylinder, it incorporates a spring-applied air-released parking cylinder.

With the exception of the cylinders, all parts of the brakes are interchangeable with those used on Wagner hydraulic brakes on like size, simplifying service and parts inventory problems.

ANODE BREAKER

△ The first metal-enclosed six-pole anode circuit breaker to permit drawout of individual poles without interruption of process power has been announced by I-T-E Circuit Breaker Co.

The single-pole drawout, providing continued supply of d-c power while one phase is being serviced, will eliminate costly downtime on aluminum reduction and other electrochemical production processes where the high-speed anode breaker is used for fault protection of mercury arc rectifiers.

With other designs, it has been necessary to completely disconnect the six-phase rectifier in order to gain safe access to any of the individual breaker poles.

In addition to continuity of service, other advantages of the I-T-E single pole drawout include: Quicker servicing—only three minutes to completely replace one breaker pole; greater flexibility in arrangement of individual breaker poles within the metal enclosure; less aisle space needed to remove and turn the breaker; smaller inventory investment—only one or two spare breaker poles need be stocked.

Representing a complete redesign, the new six-pole anode circuit breaker, designated type FB, also is lighter in weight, simpler in over-all construction and smaller in floor space requirements.

Each pole of the FB anode circuit breaker is complete in itself and may be mounted independently of other poles. Usually mounted adjacent to the rectifier cabinet, the poles may be arranged six abreast, in two groups of three abreast mounted back-to-back, or even in two groups of three abreast mounted one atop the other.

Type FB breakers can be equipped with necessary relays and controls to provide completely automatic protection of unattended rectifier stations. With these facilities, the anode breaker can be set to automatically reclose, after a predetermined length of time, a pole that has opened due to areback or any other fault condition. If the fault condition persists, the controls will trip and lock out all six breaker poles.

To minimize arcing as the breaker is closed under such load conditions, a separate closing motor is provided in each pole. Use of individual motors provides extremely fast closing time—less than ten cycles—and assures positive closing.

Fast or shunt tripping of FB anode breakers is obtained by opening the holding coil control circuit. All poles trip quickly—within one cycle—after opening of this circuit. Unbalanced load conditions on rec-

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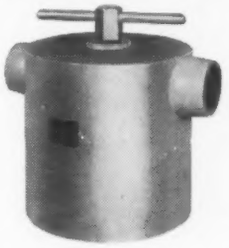

For full information, write for BULLETIN PM-44

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tifiers due to delayed opening is eliminated.

WEATHERPROOF MOTOR

△ A new weatherproof a-c motor for use in "outdoor" type applications where the motor is subjected to extreme moisture or the elements is now available from Reliance Electric and Engineering Co., in all standard speeds in sizes from one through 250 hp.

The new weatherproof motor is engineered throughout to meet the punishment of adverse operating conditions. An open motor that exceeds NEMA splashproof requirements, all of its external parts are of corrosion-proof cast iron. Shaft openings are sealed by a shaft cap and slinger.

The insulation system is completely nonhygroscopic (it cannot absorb water). It features silicone sleeving, glass-mica slot liners and glass mat top-sticks and mid-sticks. The heavy formvar wire coils are repeatedly immersed in special thermosetting, oil-and-water-resistant varnish, then sealed with a final coat of special red finishing enamel.

The rotor O.D. and stator I.D. are coated with a rust inhibitor. A special nonwashing grease is used in the Reliance "Metermatic" bearings, which meter in just the right amount of grease from the large reservoirs as needed.

The watertight conduit box is cast iron with a gasketed cover and threaded outlet. Zinc-plated, noncorrosive hex-head bolts are used throughout the weatherproof motor. The stainless steel nameplate keeps motor information permanently accessible; a quick wipe with a rag makes vital specifications legible after months of rugged outdoor service.

Protective screening for ventilating openings to keep out rodents and snakes is available on request at no additional cost.

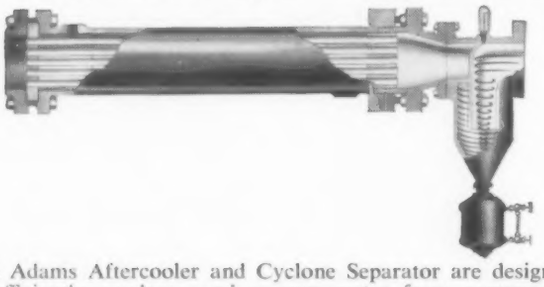
Book Reviews

"**Aids to Efficient Machine Design in Welded Steel**" has recently been produced by The Lincoln Electric Co., 22801 St. Clair Avenue, Cleveland 17, Ohio. The book contains 96 pages, 8½ x 11 in., is bound in heavy paper and sells for $1.00. The information in this manual is presented to enable improvements of machines through the efficient use of welded steel design. The information has been developed from and for the needs of designers as manifested at a continuing series of machine design seminars conducted by the Lincoln Electric Co. plant. Much of the material is original, some simply applies standard design techniques and formulas to problems of designing in steel, all of it is practical rather than theoretical and has been tested in use on a wide variety of types of machines. In the areas covered by the manual, techniques, charts, nomographs and data are given for either redesigning from an existing casting or designing from calculated loads.

"**The Calculation of Load and Torque in Hot Flat Rolling,**" by P. M. Cook and A. W. McCrum has recently been published by the British Iron and Steel Research Assn., 11 Park Lane, London. W. 1.

(*Please turn to page 314*)

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711. R. P. Adams Co., Inc., 223 East Park Drive, Buffalo 17, New York.

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Loewy flying shears deliver undistorted billets and clean cuts with close tolerances

▲ Test-shop erection of flying shear built by Loewy-Hydropress.

Loewy flying shear installed at the delivery end of a continuous billet mill at Keystone Steel and Wire ▶ Company, Peoria, Ill. Closeup view shows the shear with pinch roll unit in operation.

The difficult problems involved in the design of a flying shear for heavy stock—strictly perpendicular cut, horizontal travel, and synchronization with the speed of the material to be cut —are ideally solved in Loewy flying shears.

Due to the kinematics of the blades, the cut material will remain absolutely straight; no bending or distortion of head or tail ends can occur. Further, Loewy flying shears are electrically operated and work on the start-stop principle. For each cut, an automatic pinch roll counting mechanism initiates starting the two main motors to make one cut, after which the blades are returned to their original position. Speed and sequence of cuts can be exactly related to the speed and production of the mill.

Situated immediately at the delivery end of, and in line with, a continuous bar or billet mill, the shear shown above will cut material up to 4 in. square into lengths from 12 ft. up at speeds in accordance with the delivery speed of the mill train.

Loewy flying shears, as an auxiliary to bar and billet mills, are usually supplied with complete billet handling equipment.

Loewy-Hydropress bar and billet mills, merchant mills, skelp mills, blooming mills, strip, slabbing, structural, rail mills, special mills, and all auxiliary equipment are designed and built to customers' particular requirements. Let us know in a preliminary way what you have in mind. We will promptly show you how we can serve you and give you the benefit of every possible economy. Write Dept. C-9.

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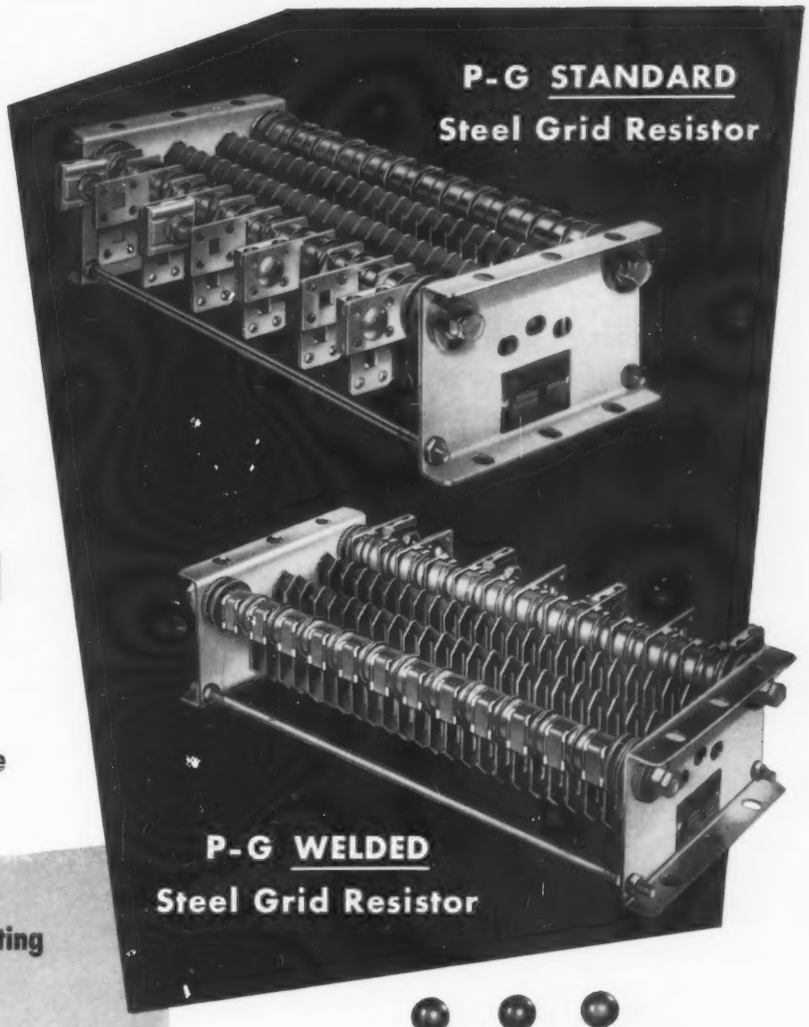
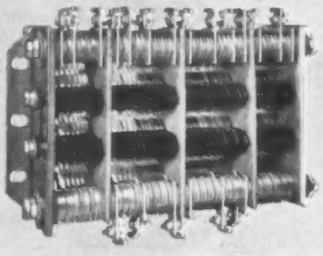


P-G Resistors for Internal Mounting in Face Plate Controllers



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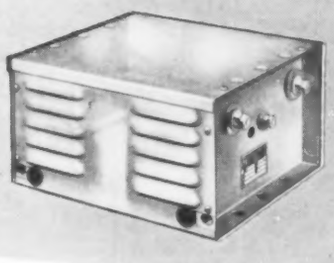

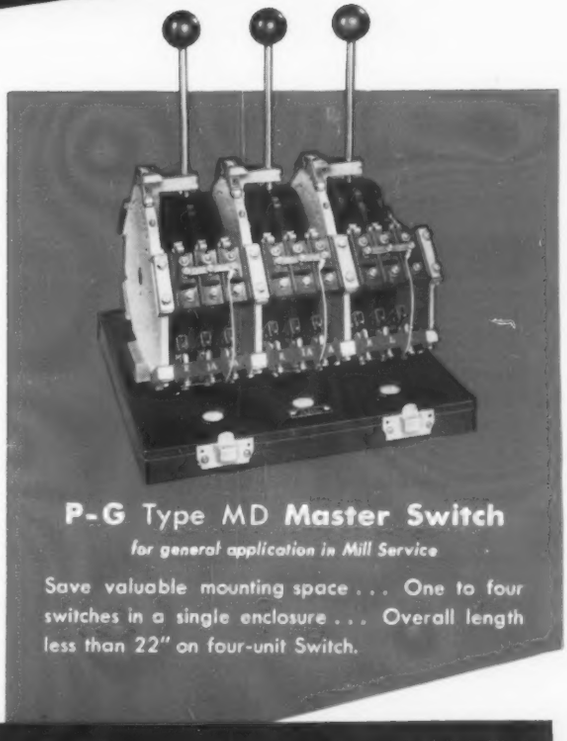

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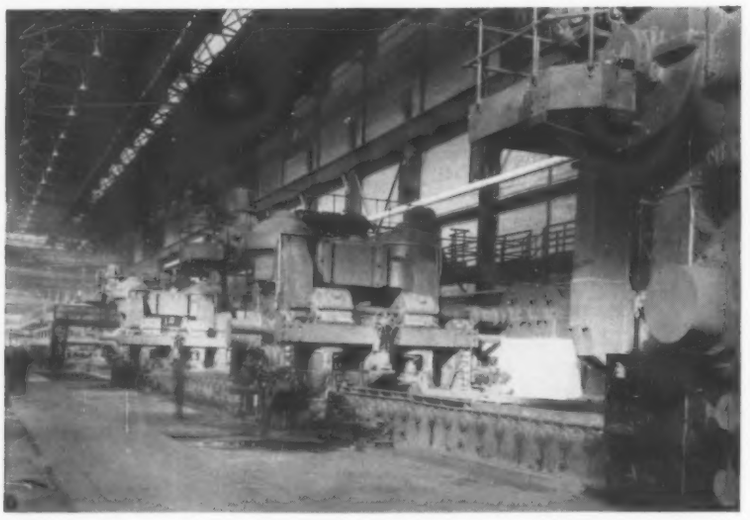

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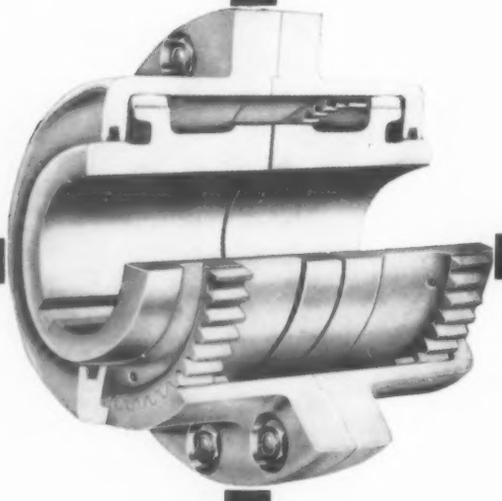

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Book Reviews

(*Continued from page 308*)

England. The book contains 109 pages, 12 x 12 in., is cloth, plastic ring, bound, and sells for $9.30, postage and packing included. The book contains in essence the results of five year's work at BISRA's Sheffield laboratories in determining stress-strain curves for steel in compression at temperatures up to 1220 C, and over a range of deformation speeds usually met in working practice. A concentration of essential data not previously available is provided. The book describes the method and contains the data for calculating the load and torque for twelve steels, and 96 large graphs are included to give the necessary "mean yield strength" data for these steels at 900, 1000, 1100, and 1200 C, over a range of strain rates and reductions covering all industrial requirements. Other graphs are provided from which the strain-rate and geometrical functions associated with any particular operation can be calculated rapidly. Also contained, in the preface, is an explanation of Sims' formulae for load and torque, and examples of calculation from the data contained in the graphs are given.

"**Estimating Construction Costs**" (second edition), by R. L. Peurifoy has been recently published by the McGraw-Hill Company, Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 446 pages, 6 x 9 in., is cloth bound, and sells for $10.75. This book clearly presents in detail how to estimate construction costs of all kinds and describes the various methods of preparing such estimates. Costs are broken down into material, labor, equipment, overhead, profit; with many examples explaining how to arrive at costs of materials, equipment, and labor for a variety of projects such as earthwork, foundations, highways, concrete, floor systems, masonry, timber structures, steel structures, utility systems, etc. Also shown are exact ways to determine production rates of both labor and equipment; costs of many types of construction equipment are given, as well as the hourly cost of owning and operating such equipment. This revised and expanded edition contains up-to-date coverage of workmen's compensation insurance, other types of applicable insurance, performance bonds; the cost of overhead and profit. Factors influencing the cost of the items are described, and amounts to use when estimating a project are given. New material has been added on the building trades, stone masonry, glass and glazing, painting, lathing and plastering, roofing and sheet metal, plumbing and electrical work coverage are included. Production rate tables have been revised to enable a selection of rates applying to a given project and conditions instead of fixed rates.

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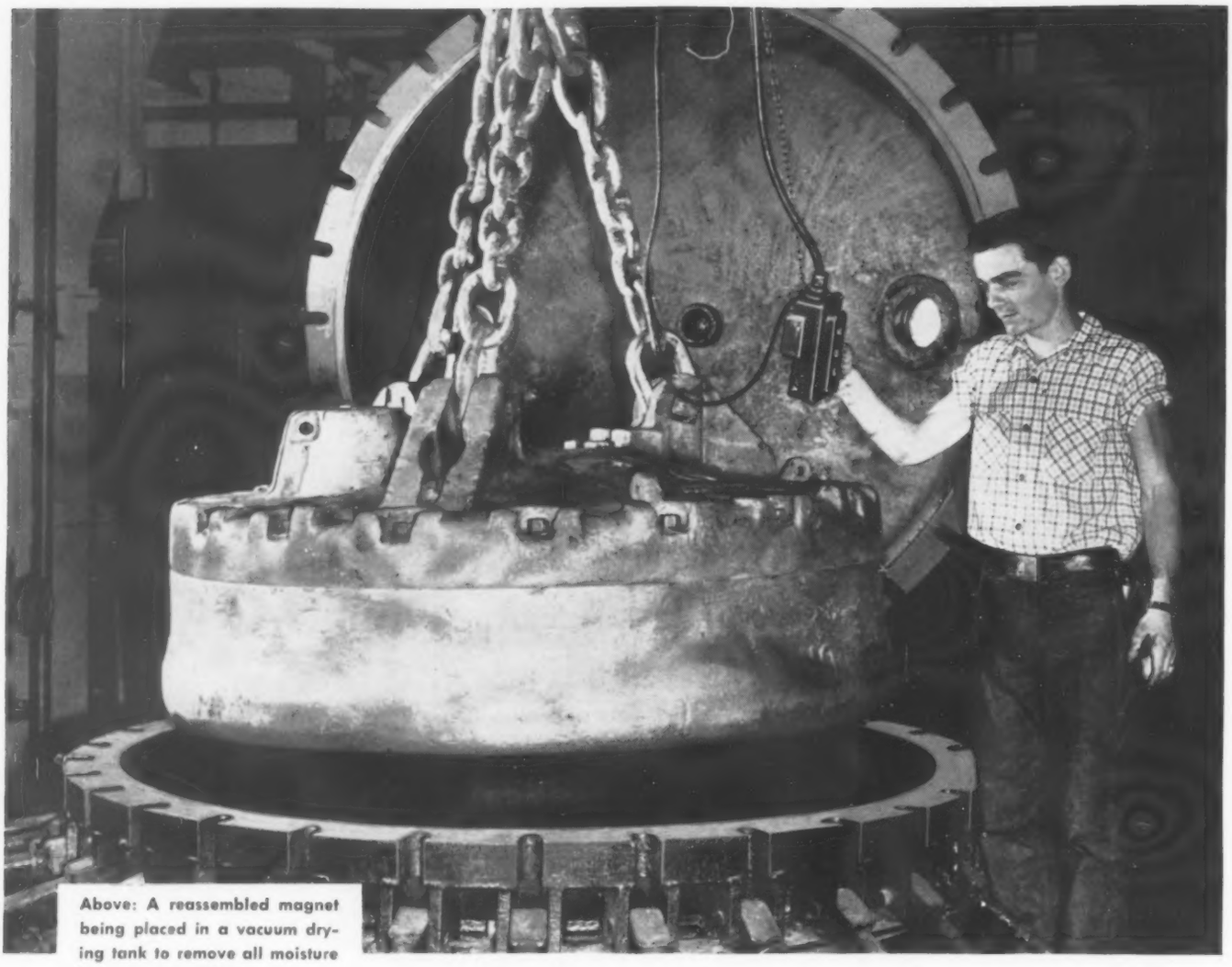

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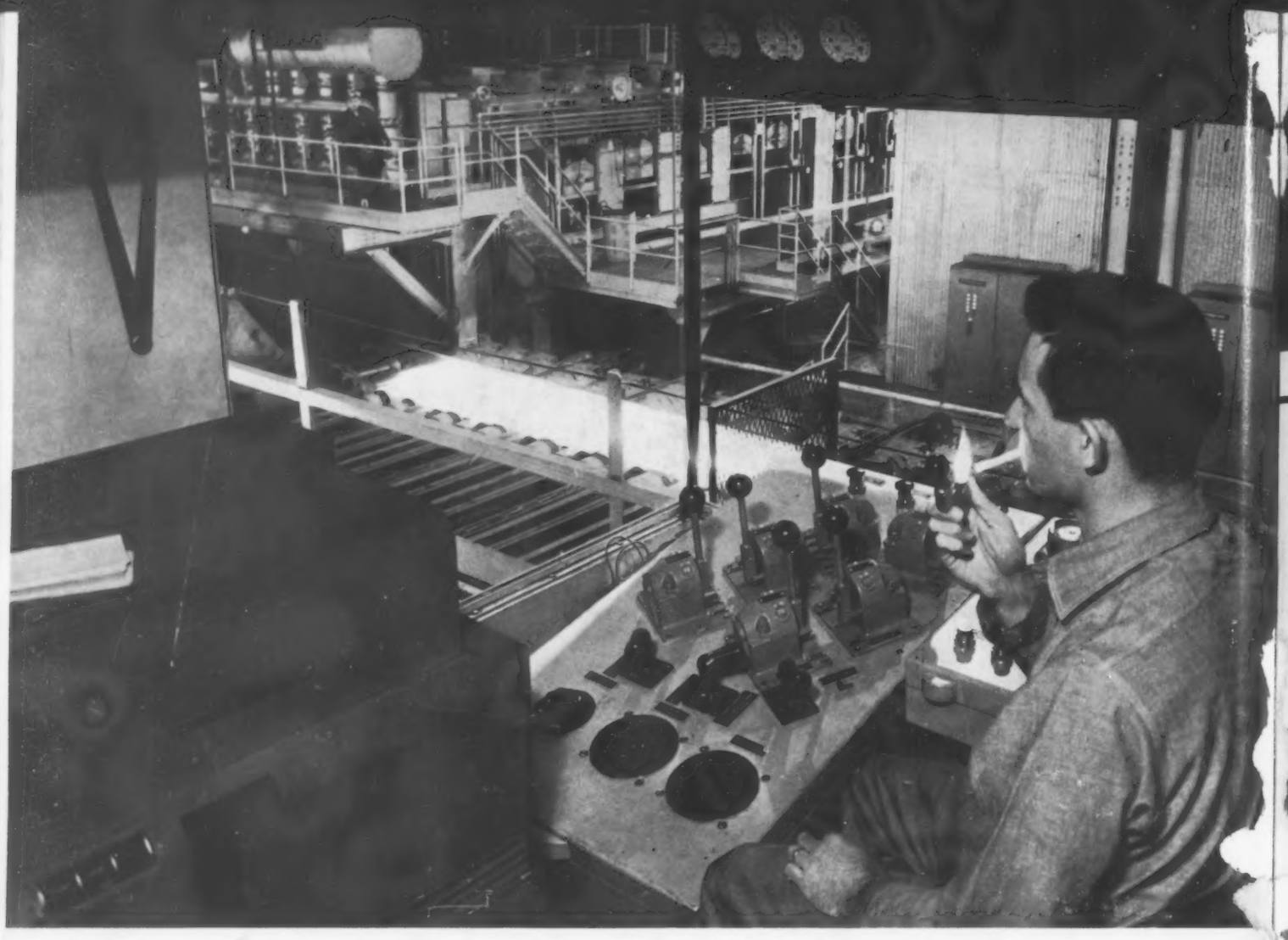

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